AGRICULTURAL ENGINEERING

SEPTEMBER · 1948

ASAE Winter Meeting · *Chicago—December 13-15, 1948*

THE JOURNAL OF THE AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS

Engineered to Encourage Conservation

● Only one short century ago, the prairie soils were so rich in organic matter that wooden and iron plows would not scour. To solve that problem was the purpose of the first steel plow built at Grand Detour, Illinois, in 1837.

When Case celebrated the centenary of that event at Grand Detour in 1937 there was something more than a happy look back over a hundred successful years. There was a new plow, deliberately designed to help restore to soils the organic matter whereof the century had despoiled them.

Dominant in the design of the Case Centennial Plow is clearance. It has room beneath the beams and between the bottoms for bulky, bushy trash to turn without touching anything that would invite bunching and clogging. It has moldboards set well forward from the beam, to cheat the chance of viny vegetation clinging and fumbling the free flow of furrow slice.

For the Case Centennial Plow there is choice both of bottoms to suit the soil, and of operation to suit the season. At the swift pace of a spring rush they leave a level, compact, well-crumbled rootbed. Going a little more leisurely, they leave the surface more lumpy, ridged to resist winter's blows and retain its snows.

Stubborn stalks of hybrid corn — straw from the combine — towering weeds or rank, recumbent legumes — the Centennial takes them all in stride, builds back the reserves of organic matter. As it conserves soil, it also conserves human toil — advances agriculture by both the old criterion of high yield per acre and the modern yardstick of high yield per man.

J. I. Case Co., Racine, Wis.

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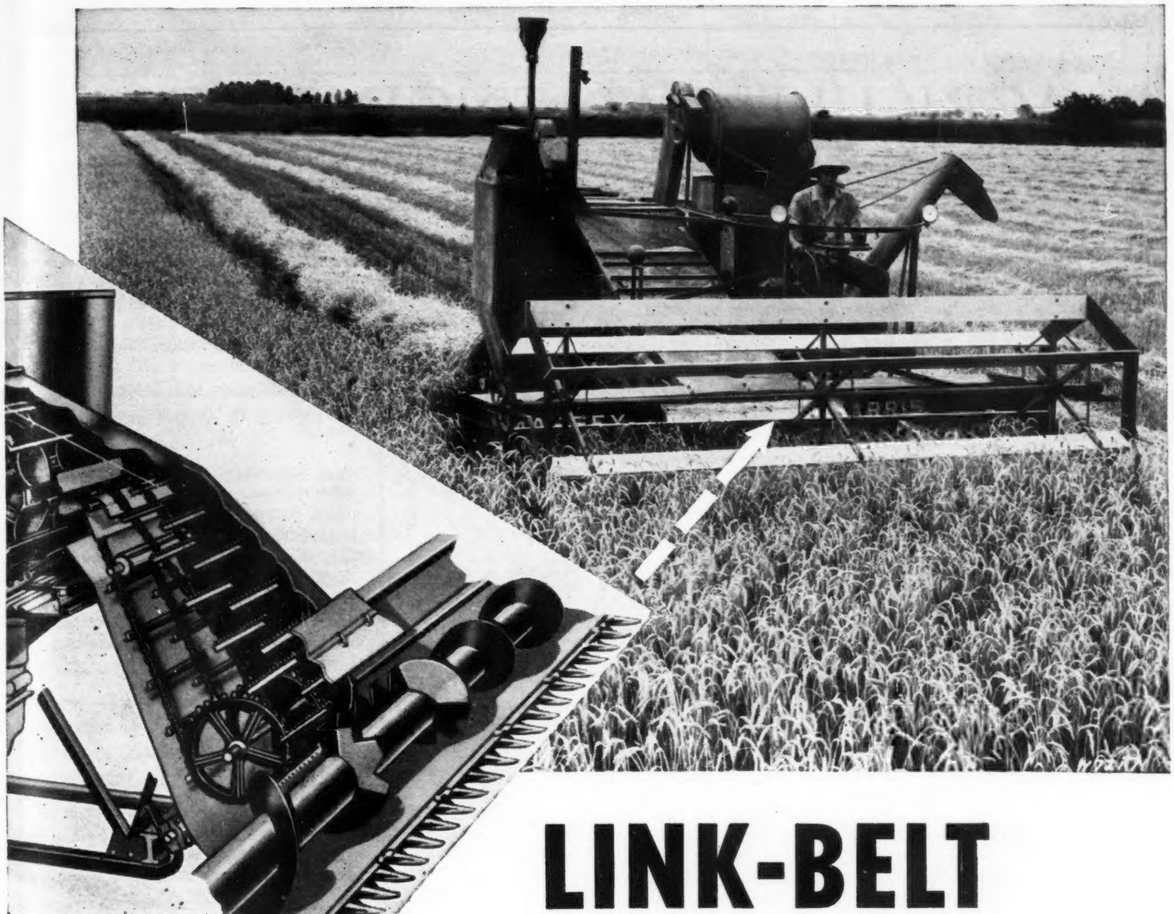

AGRICULTURAL ENGINEERING

Established 1920

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Vol. 29, No. 9

AGRICULTURAL ENGINEERING is indexed regularly by Engineering Index, Inc.

AGRICULTURAL ENGINEERING is owned, edited, and published monthly by the American Society of Agricultural Engineers. The editorial, subscription and advertising departments are at the executive office of the Society, Saint Joseph, Michigan.

SUBSCRIPTION PRICE: $3.00 a year, plus an extra postage charge to all countries to which the second-class postage rate does not apply; to A.S.A.E. members anywhere, $2.00 a year. Single copies (current), 30 cents each.

POST OFFICE ENTRY: Entered as second-class matter, October 28, 1933, at the post office at Benton Harbor, Michigan, under the Act of August 24, 1912. Additional entry at St. Joseph, Michigan. Acceptance for mailing at the special rate of postage provided for in Section 1103, Act of October 3, 1917, authorized August 11, 1921.

AGRICULTURAL ENGINEERING is a member of the Audit Bureau of Circulations.

RAYMOND OLNEY
Editor and Business Manager

EDITORIAL

Pilot Error on Ditching Machines

PILOT error of a fraction of a minute in a fast airplane can result in the plane being several thousand feet from its desired position at any given instant.

It has recently been brought to our attention that the pilot of a ditching machine can also readily be miles off the course of drainage dividends, in the several years which may elapse before defects in his work become fully evident.

W. S. Lynes, a member of ASAE and a drainage consultant and engineer, has pictured the situation briefly as follows:

"At the present time, most of the old-time tilers have passed on and a few of the younger men still tile by hand. A large number of tiling machines are operating in the upper Mississippi Valley. I believe the larger number of these are being operated by men with no engineering training or previous knowledge of drainage operations. The manufacturers have been negligent in training the operators to do good work, with the result that many thousands of feet of drain tile are going into the ground by guesswork. The operators do not know how to get the best results out of their machines. In my travels, visiting drainage jobs, I find lots of poor work. Most of the lateral drainage work, excepting in legal drainage districts, is at this time laid out by the tiler himself who is really the only engineer, if he can be called such, on the job. The mistakes in layout, size of mains, depths and spacings, and the grade are even greater than the mistakes made in operating the machine."

Mr. Lynes gives us no idle dream of a return to the "good old days" of hand-spade tiling. He pictures a bad but correctable situation, and challenges agricultural engineers to early appropriate action. Avoidable "pilot error" on ditching jobs is continuing daily, at the pace of large-scale operations, at the expense of farmers, in the field of long-term investment, in installing what are supposed to be *engineering* improvements.

Long-term results in many cases will fail to improve the financial condition of either the farmer, the custom operator, or the ditching-machine manufacturer, the professional status of agricultural engineers, or the conservation and utilization of farm land in the public interest.

Numerous manufacturers, particularly among the makers of complicated large-capacity machines for exacting work, have found it to their direct advantage to train operators and otherwise go as far as necessary to insure proper and profitable use of their products. It is as important to user satisfaction and continuing sales as sound design, precision manufacture, service, and advertising. It is not apparent that it is yet a common practice among the producers of tile-ditching machines.

Agricultural engineers can do considerable to improve this situation. It can be done by taking every opportunity to remind the manufacturers, custom operators, and farmers concerned that drainage design to determine where ditching machines should be operated, and reasonable care as to how they are operated, will pay them drainage dividends in dollars.

In fact, we believe this case illustrates an elementary principle of engineering economics which has broad applications and which will become increasingly important to agricultural engineers. Fast-moving or high-capacity machines and large-scale operations require careful engineering management to avoid large-scale errors and losses. This is particularly true where the output is a durable product, a precision product, a high-unit-value product, a distributed installation rather than compact units, a product which is mostly out of sight when in use, a product on which original errors may be difficult to detect and correct, and a product which can be justified only by several years or more of satisfactory service.

It happens that tile ditching fits all of these conditions. It had better be done right or not at all. If a farmer wants to experiment or play some hunches on tile drainage, he might far better do it on a hand-spading scale. A tile-ditching machine on the loose among a farmer's assets, in the hands of an untrained pilot, can easily prove as destructive as the proverbial "bull in a china shop."

Control and Instrumentation

A LINE of engineering thought and specialization which is developing in some of the manufacturing and process industries may have possibilities in agriculture warranting the serious attention of agricultural engineers. It is the work of the control engineer, which was recently summarized in part as follows*:

"Productivity depends in part on the amount of machinery a worker can control, which in turn is increased by more and better automatic control systems. In the war industries, especially, valuable control and instrumentation techniques have been developed and refined in the past decade. . . . Some other industries are now systematically surveying such developments for new ideas, but are hampered by a shortage of specialists in control and instrumentation who think in terms of basic techniques, which they shift readily from one industry to another."

Agricultural engineers have made substantial progress in developing and utilizing instruments and controls for research and for routine testing and measuring. Some of this instrumentation inevitably carries over into farm mechanical, structural, and electrical equipment. Thermostats and hydraulic power controls are examples. We believe that agricultural engineers are the logical personnel to "think in terms of basic techniques" in borrowing instrumentation from other industries, and in originating it where necessary, for application wherever its use may be advantageous in agriculture. With conscious attention to the basic techniques, progress in this direction might be considerably accelerated.

The engineering nature of instruments and controls and something of the type of thought required in control engineering are neatly summarized in the publication cited. The summary is repeated here in part particularly for the consideration of younger agricultural engineers who may find opportunity to work along this line:

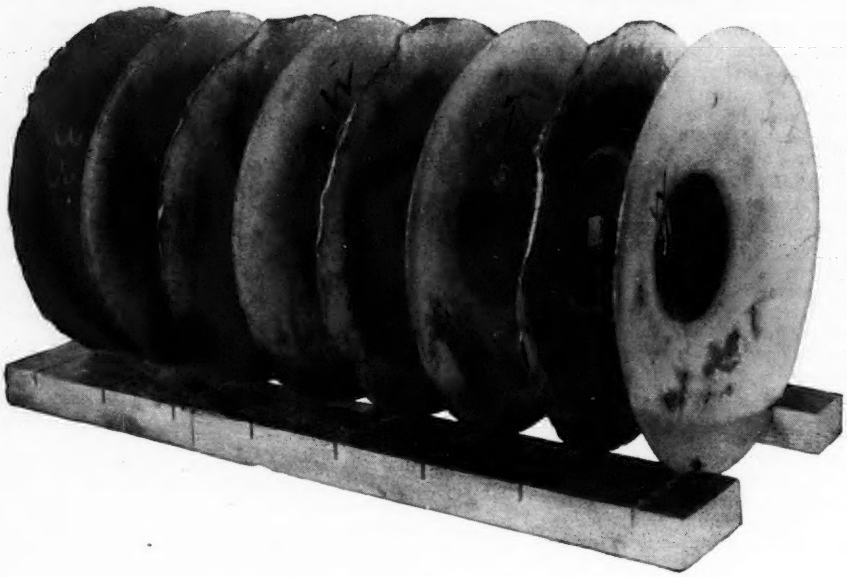
"Industrial instrument systems usually include a detector, an indicator, and a controller. The first converts some variable property of the product into a mechanical movement or an electrical change. The indicator, which may be a simple meter or a cathode ray tube, indicates and often records the difference between the actual and desired value, which may be constant or variable. The controller converts this process error thus measured into a correcting effort, such as opening or closing a valve.

"Almost any physical or chemical characteristic can be measured; the critical ones need not be controlled themselves, but must bear some known relation to those controlled. For instance, the moisture content of paper or fabric may be determined by measuring its electrical resistance. It is not even necessary to know exactly what is being measured, if the indication bears a known relation to the acceptability of the product.

"What is acceptable is a balance between the desirable and the attainable, with attention to the limitations of the plant. . . . .

"While the fundamentals of process control always remain the same, new methods and devices are constantly appearing, and wide acquaintance with developments in many fields is necessary. . . . . Devices useful in one industry, however, often create new problems when applied to other industries. For this reason control engineers commonly recommend a general plant and process survey before installing new instruments, in order that all phases of the process can be best coordinated."

*"The Control Engineer," in the "Industrial Bulletin" of Arthur D. Little, Inc., No. 244, June, 1948.



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Problems in the Design of Chemical Weed-Control Equipment for Row Crops

By E. L. Barger, E. V. Collins, R. A. Norton, and J. B. Liljedahl

Member A.S.A.E. Member A.S.A.E. Member A.S.A.E. Junior Member A.S.A.E.

CORN is one of the major crops that hold promise of treatment with 2,4-D for controlling weeds. The data presented apply also to sorghums in rows. It has been demonstrated that both of these crops can be sprayed to control weeds without damaging the crop.

Basic Requirements for Sprayers. There are two basic requirements that weed spray equipment for corn-growing areas should meet. It should be possible to adjust the equipment to do a satisfactory job of spraying for the control of European corn borer. Then without major change it should be possible to adapt the machine to spraying for control of weeds. This presents the elemental requirement that, when spraying weeds, the chemical or spray material should be controlled and directed onto the weeds, not onto the crop plant, and that when spraying for corn borer, the chemical should be placed on the crop plant.

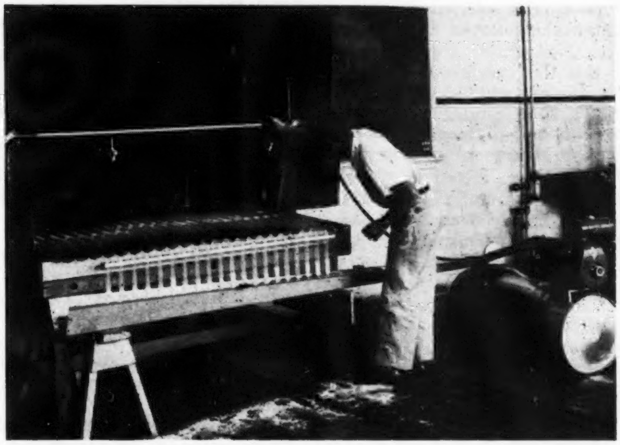
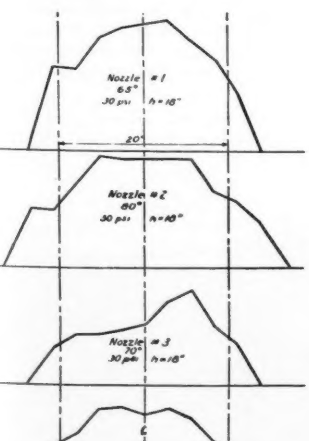


Fig. 1 Test rack for measuring spray-nozzle pattern and distribution. The aluminum sheet making up the test tray has 2.7-in corrugations. Graduated cylinders placed in front of the tray collect the spray material from each 2.7-in strip

For the control of the European corn borer, the nozzle arrangement should be such that one nozzle sprays directly down into the top of the corn plant and two nozzles spray from side positions onto the plant. It appears desirable to place DDT in the whorl of the corn plant and into the leaf shields at the side of the plant. We cannot state at this time what nozzle arrangement is ideal for borer control, but research work under way at various stations will probably answer this point in the near future.

Twenty-inch nozzle spacings along the boom of our experimental sprayers fit the requirements of the 40-in rows that are commonly used in the corn belt. In order to convert the same experimental sprayers for weed control, the spray nozzles were offset 10 in from the position they occupy when used for corn borer work. This permits operation with two nozzles between each pair of rows. To obtain this nozzle arrangement, provision was made for shifting the boom 10 in horizontally on the tractor or trailer on which it was mounted. A similar effect may be obtained by placing a plug in the nozzle directly over the row and using drop pipes on 40-in spacings with double nozzle heads working midway between the rows as will be discussed later. Plans and a description of such an experimental sprayer have been prepared by Hull and Barger* and are available in mimeographed form.

Controlled rate of applications of material should be one of the aims in the design of spray equipment. To obtain data on this problem, distribution tests of individual nozzles were made. Fig. 1 shows the test apparatus used for nozzle



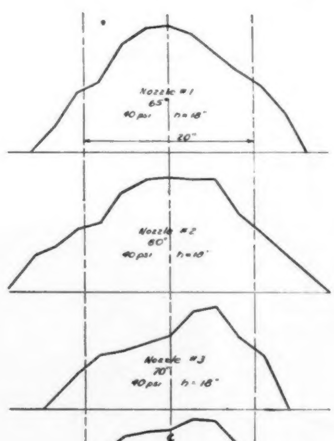


Fig. 2 *(Left)* Distribution patterns of four typical fan-type weed-spray nozzles at 30-psi pressure • Fig. 3 *(Right)* Distribution patterns of the same four nozzles shown in Fig. 2 but at 40-psi pressure

This paper was presented at the annual meeting of the American Society of Agricultural Engineers at Portland, Ore., June, 1948, as a contribution of the Power and Machinery Division. Authorized for publication as Journal Paper No. J1592 of the Iowa Agricultural Experiment Station, Project 1002. This is a report of a study, certain phases of which were carried on under the Research and Marketing Act of 1946.

E. L. BARGER and E. V. COLLINS are research professors of agricultural engineering and J. B. LILJEDAHL is research assistant professor of agricultural engineering, Iowa Agricultural Experiment Station, Ames. R. A. NORTON is agricultural engineer, Bureau of Plant Industry, Soils, and Agricultural Engineering, U. S. Department of Agriculture, stationed at Ames, Iowa.

*Hull, D. O. and Barger, E. L. Suggestions for assembling spray equipment for weed and insect control. Agri. Ext. Serv., Iowa State Coll., Ames, Iowa. AE-562 (9 pp. mimeographed), March, 1948.

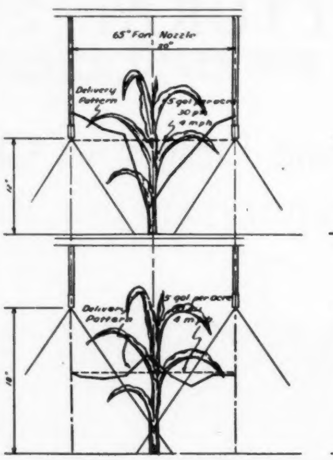
testing. It consists of sheet of corrugated aluminum roofing with 2.7-in corrugations. A section 4x6 ft makes up the test tray. The tray is so mounted that corrugations are inclined in their longitudinal direction (the 4-ft dimension) and drained to the front. At the bottom of the incline is a rack holding graduated cylinders. Above the test tray, and mounted on standards providing height adjustments, is a pipe which carries the nozzles to be tested. A pump with pressure-control, pumps a standard mixture of butyl ester 2,4-D and water through the nozzles for testing. The standard mixture used in these tests was 1 qt of 40 per cent 2,4-D liquid to 10 gal of water.

Figs. 2 and 3 show results of tests of individual nozzles. They are averages of three replications made with commercial fan-type nozzles selected at random. Fig. 2 shows the distribution of four fan-type nozzles at 30 lb pressure. Nozzle No. 1 is a 65-deg nozzle. It can be seen that this nozzle delivers about twice as much material in the center 2.7 in as it does at the outer edges of a 20-in band. This test was run at a nozzle height of 18 in. If spraying is being done at a rate of application close to an amount that would cause crop damage, it can be imagined at least what the effects on the crop plant might be if a nozzle were placed directly over the crop row. On the other hand, little damage might result if the nozzle was placed so the crop plant was at the outer edge of the fan.

No. 2 is an 80-deg nozzle. This nozzle was tested at 30 lb pressure and at a height of 18 in also. Again at the 20-in point, at the edges of the fan, the rate of application is only 66 per cent of that at the center 2.7-in section. No. 3 is a 70-deg nozzle. While considerable variation exists with different nozzles of the same number and make, frequently an odd pattern is formed. This nozzle gives a high point, not in the center, but at a point 5 in to the right of center. The rate of discharge is about twice as great at the peak as at the 20-in points. No. 4, an 80-deg nozzle, under the same test conditions varies 36 per cent between the high point and the 20-in point.

Fig. 3 shows the same nozzles in the same order but at 40 psi pressure. In general the fan angle or width of coverage is increased. The uniformity of application is essentially the same as with the 30-psi pressure.

Figs. 4 and 5 show what happens when two fan-type nozzles operate on a multiple-nozzle boom. The first illustration shows the distribution curve plotted on a schematic diagram of corn plants located between 65-deg nozzles. The figure in the upper portion of the illustration is with a 12-in nozzle height. The rate of application is not uniform. The center portion receives only about one-fourth of the average. On the other hand, it might be a desirable condition if it is desired to put a minimum amount of material on the crop plant and if the nozzles are located so as to place the plant at the midpoint between the nozzles. The boom is placed too close to the ground to obtain uniform coverage. This may happen if the boom is improperly placed. It also happens on irregular



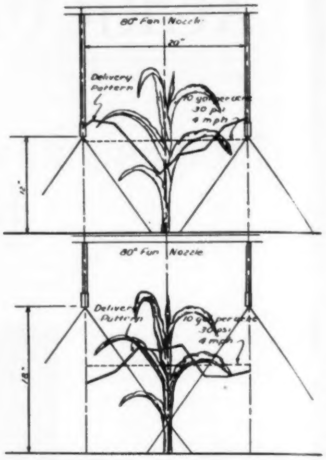


Fig. 4 *(Left)* Spray-delivery patterns about a corn plant showing fan angle, delivery pattern, and average rate of application with a 65-deg nozzle at 12 and 18-in heights • Fig. 5 *(Right)* This figure is identical to Fig. 4, except the nozzles used are 80-deg fan type

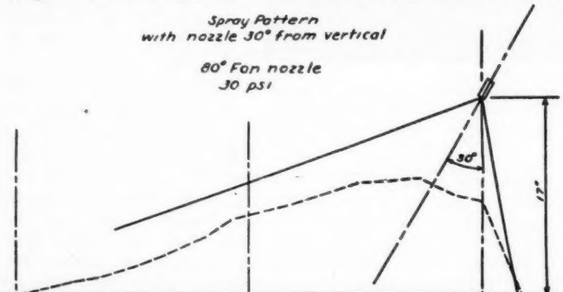
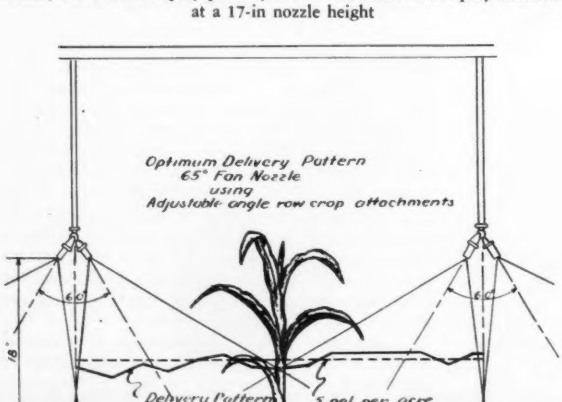


Fig. 6 Diagram of results of test of an 80-deg fan nozzle placed at a 30-deg angle from the vertical. This shows the angle of the fan produced, the width of spray pattern, and the distribution of spray material at a 17-in nozzle height



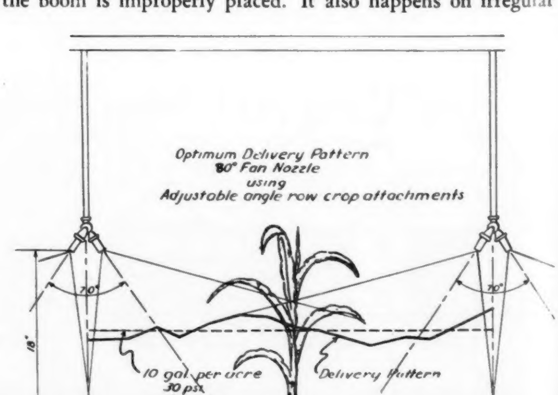
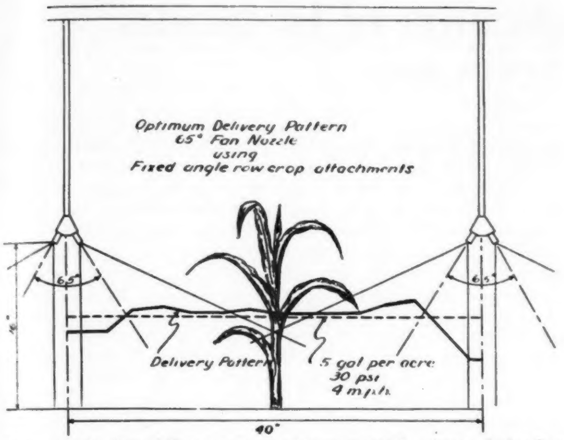


Fig. 7 *(Left)* This figure shows best adjustment for uniform distribution with multiple-nozzle heads on 40-in spacings. The included angle is 60 deg and the height is 18 in • Fig. 8 *(Right)* Optimum uniformity of distribution with multiple 80-deg nozzle was obtained with 18-in height and 70-deg included angle when tested on 40-in row spacing



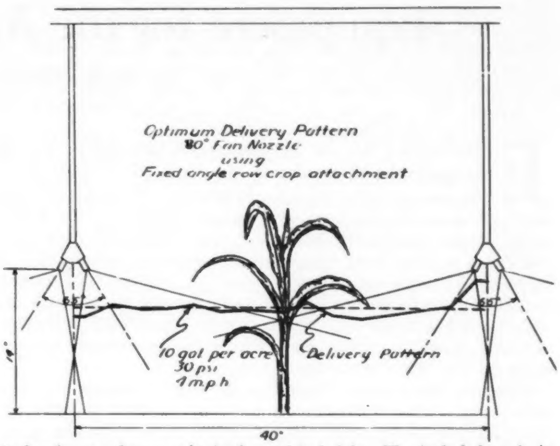


Fig. 9 *(Left)* Best delivery pattern with commercial twin-nozzle heads and 65-deg fan nozzles was obtained at 16-in height. The included angle is fixed at 65 deg • Fig. 10 *(Right)* Eighty-degree fan nozzles on fixed-angle twin nozzles gave optimum delivery pattern at 14 in height

ground when the overhanging end of the boom passes over a ridge or high point.

The lower half of the illustration shows a test made at 18-in height which gave a more desirable distribution. It can be seen from the curve that the sum of the discharges from the nozzles give a rather uniform rate of application over the entire width and generally falls on the 5-gal-per-acre line. A slight peak occurs in the center, which would be desirable if weeds were numerous in the row between the corn or crop plants. Also, it should be pointed out the height of spray pattern should be such as to concentrate the spray on the weeds and not on the crop plant. This of course assumes the weeds to be something less in height than the crop plant.

Fig. 5 shows a similar test, but with 80-deg nozzles. The boom heights are 12 and 18 in and the pressure is 30 psi as in Fig. 4. Due to the wider angle a more uniform rate is obtained at the 12-in height. At the 18-in height the distribution is similar to the 65-deg nozzle, but with slightly greater concentration of spray material in the center row area.

A test of an individual 80-deg nozzle placed at 30 deg from the vertical is shown in Fig. 6. The total width of spray pattern is about 40 in. The rate of distribution is shown in broken line and varies greatly over the 40-in width. The 20-in space to the right and adjacent to the nozzle is fairly uniform and the gradually decreasing rate of the outer part of the fan indicates possibilities in combining nozzle patterns to get uniform rate of application. Such combinations are shown in the following illustrations.

Fig. 7 shows the best combination of nozzle angle and height for uniform distribution with multiple 65-deg nozzles. The drop pipes are 40 in on center. The nozzles are 30 deg

Fig. 11 A high-clearance row-crow sprayer spraying grass land and using an experimental crossover-type of string guide for driving. The end stakes are drag anchors. The action is automatic

from the vertical and 18 in high. The distribution curve coincides nicely with the 5-gal-per-acre line.

Fig. 8 shows the same situation with 80-deg nozzles. The height is again 18 in. The included angle is 70 deg, or each nozzle is 35 deg from the vertical. Good distribution was obtained as indicated by the conformity of the distribution curve to the 10-gal-per-acre line. A corn plant is placed in the spray pattern at the proper point to illustrate the general problem.

Commercial twin-nozzle attachments are on the market. Figs. 9 and 10 show distribution with one of these attachments. The included angle is fixed at 65 deg. Fig. 9 shows the best distribution obtainable with 65-deg nozzles. A 16-in height proved to be the best. The distribution is good except directly below the drop pipe where the fans fail to meet. A wider-angle fan would improve the distribution. Fig. 10 shows 80-deg nozzles used on the attachment. Best results were obtained at a 14-in height and, as indicated by the curves, the distribution was excellent.

Markers for Spraying. In spraying pastures, lawns, and small grain fields it is desirable to cover all the ground and not double treat any portions. Double treatment not only wastes material but may injure the crop. Fig. 11 shows an experimental marker as one solution. It corresponds to the action of a cross over wire used in checkrowing corn, except that cord is used and a drag is used instead of stakes. As the end of the field is approached, the drag is lifted by the tension in the cord and as the unit is turned, the drag is carried around and dropped as the driver straightens out the tractor. One simply follows the cord. It has been found difficult to turn and maintain tension in the cord. This problem would be aggravated if the cross over was on a boom in front of the tractor. An automatic lock connected to the steering gear should be added to hold the drag block in the lifted position until the tractor straightens out after completing the turn. It would also be desirable to have a reel for the cord, built into at least one of the drags so adjustment could be quickly made for length of run.

High-clearance spray rigs such as the one illustrated in Fig. 11 present some problems. The one thing unique about them is clearance. They are intended to answer the need for spraying second brood corn borer and late weed growth in corn. The real question is whether or not either of these spraying conditions will be serious enough to demand such equipment. There is some doubt that weed spraying past the lay-by stage of corn will be needed. Possibly the cumulative effects of early weed control will reduce the weed populations to the point where such late weed pests as cocklebur, sunflower, and button weed will not require spraying after the corn is full grown. Also effective control of first-brood corn borer may make late spraying unnecessary. The high-clearance machine shown is a combination of sprayer and detasseling machine. *(Continued on page 389)*

Equipment for the Application of Herbicides

By N. B. Akesson and W. A. Harvey
Member A.S.A.E.

EQUIPMENT for the application of herbicides falls into two general classes: that for applying dry materials and that for applying liquids. Several of the herbicides may be applied as dusts using conventional dusters, although such applications are limited because of the hazard of drift. Soil sterilants such as borax, sodium chlorate, and arsenic may be applied dry with equipment similar to fertilizer distributors. Other soil sterilants are applied as liquids on the ground surface or are injected into the soil with specialized equipment which is usually owned and operated by the commercial concern making the application.

By far the greatest interest in application equipment is in spray rigs. Some use is being made of air-diluted spray systems, but the commonest method is that of a hydraulic spray-type discharge.

In California, weed control with various oils, dinitros, and other chemicals has been satisfactorily practiced for many years. With the advent of 2,4-D, new impetus has been given weed control, and new techniques have been found necessary. Thus the spray rig for California must be able to handle oils, dinitros, and emulsions and suspensions, as well as 2,4-D; and our problem has been to improve existing equipment as well as adapt it to 2,4-D, with emphasis on the fact that equipment for low-volume application of the latter only will not handle the job for the many other chemical herbicides.

There are five factors to be considered which determine the design and size of a spray rig. The first is the weed problem or problems for which the sprayer will be used. Following are the most frequent types of herbicidal spray applications in California, and the rates of application and pressures recommended:

1 Pre-emergence sprays consisting of oils, oil emulsions, or fortified oils sprayed on planted fields before the crop emerges. Low volumes of 20 to 60 gal per acre are used at 40 to 80 psi (pounds per square inch).

2 Selective oil sprays in carrots and related crops applied at rates from 40 to 100 gal per acre at pressures of 40 to 80 psi.

3 Oils and fortified oil emulsions for killing annual weeds in dormant alfalfa. Volumes range from 100 to 150 gal per acre; pressures, 40 to 80 psi.

4 Selective sprays in such crops as grain, peas, onions, and seedling alfalfa. Volumes vary from 2 to 120 gal per acre. Several chemicals are used, depending on the crop. Probably the most significant is 2,4-D in low volume and with low pressure of 15 to 50 psi.

5 General contact weed control using volumes of 100 to 400 gal per acre of any of a variety of herbicides; pressures from 100 to 125 psi.

The second factor in the design of the sprayer is boom requirements. For field spraying in large fields of grain, alfalfa, or row crops, booms of 40, 60, or even 100 ft in length are used, while in orchards and in small grain and row-crop fields, shorter booms of 6 to 20 ft are common. The row-crop booms will be designed to cover a certain number of beds or rows. The length of the boom and the discharge rate are the controlling elements for all the remaining portions of the sprayer. The maximum length will be limited by the increased bulk and expense of tank, pump, and supporting members for the long boom. Where large acreages are to be sprayed with high volumes, it may be most practical to use several small rigs instead of one very large machine.

The length of boom required to cover a given acreage in a stated time may be found from the following equation: $(43{,}560 \times \text{acres})/\text{actual working hours} \times \text{mph} \times 5{,}280$. Thus with a 250-acre field to be covered at 5 mph in three 8-hr days (assume 70 per cent field efficiency), the boom would have to be about 24 ft. An approximate rule may be used: At 5 mph and three working days, one foot of boom should be allowed for each 10 acres of land to be sprayed. This gives a 25-ft boom for the example above. If the speed is halved, the boom length would have to be doubled.

The third factor, size of pump, depends upon the discharge and pressure required and on the boom length as discussed in step 2. The pump size in gpm (gallons per minute) is equal to $\text{mph} \times 5{,}280 \times \text{boom length (ft)} \times \text{gal per acre}/43{,}560 \times 60$.

Thus if 100 gal per acre is the maximum to be applied by the machine, the rate of travel is 5 mph, and the rig has a 25-ft boom, the pump must handle 25 gpm. From this another approximate rule may be established to quickly find pump capacity: For each 100 gal per acre at 5 mph, the pump must supply 1 gpm for each foot of boom length at the pressure recommended for the application.

Engine size constitutes the fourth factor. The equation, $\text{gpm} \times \text{psi}/1730 \times \text{efficiency}$, will give the power required. The efficiency varies for the different types and sizes of pumps and runs from as low as 20 per cent for the small units to 80 per cent for the larger, better-designed pumps. The engine rated horsepower for continuous operation should be greater than the horsepower requirement of the pump by 20 to 30 per cent.

The fifth factor concerns the size of tank to use. There is no satisfactory mathematical relationship to determine this factor, as the size will be dependent upon not only the size of boom and pump but also on concentration of spray mix and availability of water. For the hand boom or for spraying a concentrated solution, a 50-gal barrel may be sufficient; while for field spraying with a pump of 50 to 100 gpm where water is scarce, a 1,000-gal tank may be desirable. For the medium-size, general-purpose sprayer, tanks from 150 to 300 gal are common. A nurse tank with a small engine and pump unit to mix and transfer materials will be found convenient.

The five factors above outline the general size requirements of the weed sprayer. A more detailed discussion of the various parts of the sprayer follows.

Chassis and Sprayer Mounting. Mounting design follows four standard approaches with variations within these groups. Skid mount, where the entire unit—pump, engine, tank, and boom—is bolted to skids and may be placed in the back of a pickup truck or on a trailer. Tractor mount, with the pump driven from the tractor engine and 50-gal barrels slung from the sides of the tractor or on the drawbar at the rear. The boom may be at the front of the tractor or mounted in the rear. Self-propelled rigs are made using built-up truck frames and engine drives or more frequently using war surplus weapons carriers or jeeps with the spray pumps, tanks, and booms mounted on them. The last, most common in California, is the trailer-mounted rig. The tank should be directly over the wheels to maintain load balance whether the tank is empty or full. Regular 6:00x16 automobile tires will carry accessories and tanks up to 300 gal capacity. For larger sprayers, aircraft, truck, and implement tires are available to handle up to 800-gal tanks.

When the sprayer is used on row crops, the wheel spacing should be adjustable, using hollow axles, stub axles, or movable wheels on a fixed axle.

Pumps. Several types of pumps are available for the

This paper was presented at the annual meeting of the American Society of Agricultural Engineers at Portland, Ore., June, 1948, as a contribution of the Power and Machinery Division.

N. B. AKESSON is instructor, division of agricultural engineering, and junior engineer in the agricultural experiment station, and W. A. HARVEY is associate in the division of botany and in the agricultural experiment station, University of California, Davis.

weed sprayer. These may be grouped as positive displacement and non-positive displacement. The first group is self-priming and requires by-pass type regulation. Plunger pumps, gear, and various rotaries fall into this group and are all satisfactory as to type, but the plunger, because of high original cost due to its high-pressure characteristics, is generally not used for the weed sprayer unless it is also to be used for high-pressure orchard or cattle spraying. Gear and rotary pumps are satisfactory when operated according to manufacturer's specifications with regard to the pumping of lubricating or non-lubricating liquids and gritty materials. The latter can seriously shorten the life of these pumps.

Non-positive displacement pumps are not self-priming; but if these pumps are mounted below the tank level, or if provided with special holding wells, check valves or aspirators, priming troubles can be reduced. Centrifugals, regenerative turbines, and flexible impeller pumps fall in this group. The centrifugal is the most common and may be purchased direct-mounted and connected to light air-cooled gasoline engines. The pressure produced by the centrifugal pump is a function of rotor peripheral velocity (P is proportional to V^2); and in order to get the pressures needed for weed spraying, it is necessary to drive the small compact centrifugals at high rotor speed or else have a multistage pump. The regenerative turbine is a centrifugal type with many fine blades on the rotor periphery. This type gives higher pressure with smaller impellers and lower speed than the ordinary centrifugal pump. Flexible impeller pumps are finding favor in certain areas, principally because of their low cost and ability to handle gritty liquids; but the action of oil sprays deteriorates the impellers quite rapidly, and their basic design seldom permits pressures over 50 psi, which is not sufficient for many types of spray applications. Although the flexible impeller pumps are not positive displacement, they are self-priming on low suction heads.

Hydropneumatic Systems. These are meeting with favor when used for orchard weed control or small field sprayers. They have the advantage of not pumping liquid through the pump, thus reducing the wear. The tanks, however, must be airtight and heavy enough to withstand the 80 to 100 psi the compressor builds up. Air on top of the liquid forces the spray mix out of the tank. Agitation is another problem for these machines; but the latest type has a mechanical agitator with compression glands built to withstand the tank pressure.

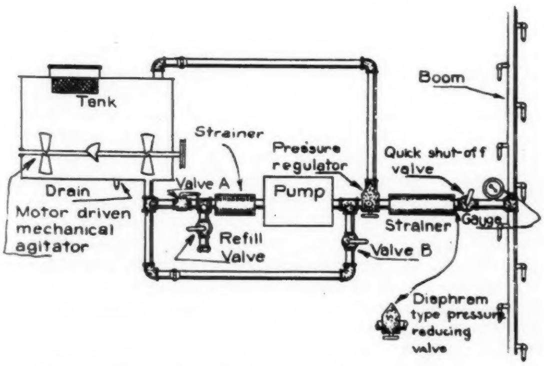
Power for the pumps is most frequently provided by a direct-drive gasoline engine. A number of the pump manufacturers are building units consisting of a pump and engine direct-connected and mounted on the same frame. These units are designed for one another and are better purchased in this manner than as separate pump and engine. Power take-off drives are being used, most commonly when the sprayer is mounted on the tractor. However, most users of power take-off equipment agree that the versatility of the sprayer is seriously handicapped when coupled to the tractor engine and thus limited by the interrelation of field speed and pump speed. Whatever the type of drive may be, the essential condition is that it provide adequate power to the pump for maximum pump effectiveness.

Pressure Regulators. Relief valves or regulators and reducing valves are essential for the proper operation of the spray rig. As mentioned under pumps, the positive displacement types require a by-pass flow relief valve or regulator to allow the flow in excess of that used by the boom to be by-passed to the tank (Fig. 1). Pressure control is obtained by altering the spring tension in the regulator. At all times there must be excess flow by-passed by the regulator in order for it to function properly, maintaining constant pressure on the boom. The high-pressure regulator provided with the orchard plunger pump will in most cases not be satisfactory for weed pressures and should be supplemented with a pressure-reducing valve. These devices are similar to those used on the oxyacetylene welding torch. They maintain pressure control through pressure differential apparatus and have no by-pass flow. In addition to their supplementary use with the regulators on the positive displacement pumps, they may be used alone on the non-positive displacement types because shutting off the discharge from these pumps will not damage them.

A simple globe or gate valve may be used with the non-positive displacement pumps and control obtained by adjusting this valve in the boom line to the correct pressure with the nozzles discharging at the desired rate (Fig. 2). This system is satisfactory if the pump pressure doesn't vary; but in most cases, for accurate control, it is necessary to use the regulator or reducing valve to keep constant pressure on the boom.

Tanks. The tanks for weed sprayers should be made of metal. Iron tanks are used, as well as aluminum or other light material. Wooden tanks may absorb toxic chemicals. It is especially important to be able to clean the entire spray system thoroughly after using 2,4-D. For cleaning out oil-soluble forms, it is recommended that kerosene be used for the first rinse followed by lye or washing soda of a strength of 1 to 2 lb of lye per 25 gal of water. The lye solution is run through the machine followed by several water rinses. Where the water soluble 2,4-D is used, a rinse followed by soaking the entire system with water overnight or longer is recommended. After the soaking process, the lye or washing soda rinse is used, followed again by fresh water. A large opening in the top of the tank and a sump or low drain point in the bottom of tank facilitates cleaning and draining.

Agitation. Agitation systems may be either mechanical or hydraulic. The former is more efficient and generally appears to give best results. This system consists of a series of paddles mounted on a shaft through the ends of the spray tank and driven by a reduction drive from the pump engine. The ends of the paddle blades should have a total width approximately equal to one-half the length of the tank, and



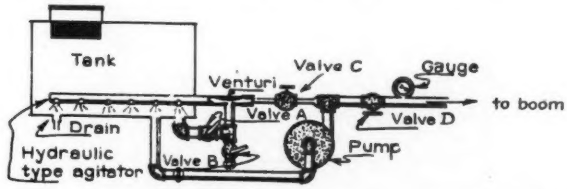


Fig. 1 (*Left*) Diagram of a weed sprayer using a positive-displacement pump and mechanical agitation. A diaphragm-type, pressure-reducing valve is inserted as shown when pressure regulator will not function properly below 100 psi. Backfilling is accomplished by attaching suction hose at the refill valve, opening refill valve, closing valve A and opening valve B. Recommended screen mesh for strainers is: top of tank, 50 to 80; pump input, 50 to 80; boom input, 100 to 150; nozzle screens, 100 to 200, depending on the orifice size • Fig. 2 (*Right*) Diagram of a weed sprayer using a non-positive displacement pump and hydraulic agitation with a Venturi system. Valve C controls the amount of agitation flow, and valve D is used to set the boom pressure (with boom discharge open). For accurate pressure control, valve D is replaced with a pressure-reducing valve (shown in Fig. 1). Backfilling is accomplished with the Venturi system by attaching suction hose at valve B, opening valve B, closing valve A, and opening valve C. Boom shutoff valve and boom not shown

their length should be sufficient to sweep within ½-in of the bottom of the tank. Peripheral speed of the blades varies with the depth of liquid to be agitated but is about 400 fpm, or 128 rpm for a 12-in blade in a 3-ft diameter, 250-gal tank. About ¼ hp is required to drive this agitator. If a flat-bottom tank is used, the revolutions per minute of the agitator must be increased 20 per cent; and the power required will be increased 50 per cent (the horsepower varies as the 2.9 power of the agitator revolutions per minute).*

Hydraulic agitation requires no moving parts in the spray tank and is readily installed. A centrifugal pump is generally used with this system because of the high discharge volume needed. The excess flow at boom pressure is recirculated to the spray tank and forced out through many small openings in a pipe laid in the tank bottom. This method is satisfactory if sufficient recirculation is used. No accurate data is available as to the amount of agitation flow required for various spray mixes and tank shapes. However, it appears the hydraulic system is much less efficient than the mechanical and requires approximately 30 gpm at 100 psi for a 3-ft diameter, round-bottom, 250-gal tank. Flat-bottom tanks should have 30 to 40 per cent more agitation. Power requirement ranges from 3 to 4 hp for a tank of these dimensions.

Refilling the spray tank may be accomplished through the use of suitable backfill connections, valves, and hose which utilize the sprayer pump to draw water from wells or ditches and force it into the tank. Gritty water will quickly ruin the spray rig. Filling from ditches is poor practice at the best, and all possible protection should be given the rig by using strainers and filters on the backfill hose.

Strainers. In addition to the strainer in the backfill hose, a strainer with a similar size screen, 50 to 80 mesh, should be installed at the tank fill opening and another of the same mesh at the input to the pump. This latter is most commonly used with the positive displacement pumps to keep large particles out of the pump. A boom line strainer between the regulator and boom stops the entry of dirt particles to the boom and nozzles, thus reducing delays from plugged nozzles. This strainer should have about 75 sq in of area of 100 to 150-mesh wire screen when used on the general-purpose sprayer. Nozzle screens are necessary, particularly for the small opening nozzles. These screens are very small and cannot be expected to carry the job of the other strainers but are to catch the few particles that might otherwise stop in the nozzle orifices.

*French, O. C. Spraying Equipment for Pest Control. California Agr. Exp. Sta. Bul. 666:1-42. 1942.

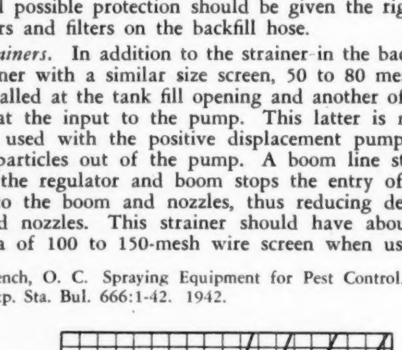


Fig. 4 This chart shows the height of nozzles above weeds required to give single complete coverage for 6 to 48-in nozzle spacing on boom and various nozzle spray fan widths

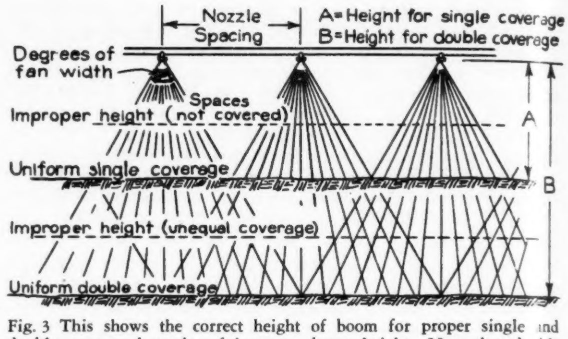


Fig. 3 This shows the correct height of boom for proper single and double cover and results of improper boom height. Note that double coverage does not increase the amount of spray applied per acre

Boom Control Valves. A good, quick shutoff valve with connections the same diameter as the boom should be placed in the main boom line and arranged with a remote control to bring is within reach of the operator. A good valve for this job is a spring-loaded poppet valve with a ratchet handle and a double eccentric. This valve is operated with a jerk line and so arranged that a pull through about 45 deg will turn the eccentric and open the valve, after which the handle is released; and the ratchet returns. Another pull on the handle will again turn the eccentric and close the valve. Releasing the handle returns the ratchet to the original position.

Pressure Gages. A properly calibrated pressure gage of good quality should be installed in the line from pump to boom between the boom and the shutoff valve. The gage should be of 3 to 4-in diameter and have a maximum reading of 150 to 200 psi. The operator should be able to read the gage easily from the tractor or driver's seat. Gages should be calibrated each season by a reliable pump or sprayer service or at least checked against another gage so that serious errors in readings will not be overlooked.

Booms. Pipe of from ¾ to 2 in diameter, of galvanized, black iron or light alloy may be used for the spray boom. The 1-in size is sufficient for the 15-ft boom, with 1¼-in to 1½ in or larger recommended for longer booms. Pipe smaller than 1 in is not practical because the resistance to liquid flow will cause a drop in pressure at the nozzles when large volume spray work is being done. For example, in 10 ft of 1-in pipe, a 25-gpm flow will cause a 3 psi drop, which would lower the discharge on the outside nozzles. Further, it is easier to cut holes in the larger pipe for the nozzles; and the greater strength gives increased rigidity to reduce whipping and possible buckling. Small tubing of copper or other metals is sometimes used for very low volume work with 2,4-D. In such a case, the small pipe will require some method of support but has a decided advantage with respect to the amount of liquid held in the boom which is lost or dribbles out when the pressure is shut off.

Both lateral and vertical support must be given the boom. The vertical support may be light chain, cable, or rod, while a single ½-in rod or pipe will give sufficient lateral stiffness. It is necessary to allow for raising and lowering the boom, and the support members must be designed to permit quick changes in boom height. Simple U bolts fitted to the boom and arranged to match holes of different heights in a drilled frame are satisfactory and can be designed to provide variable heights from 10 in to 3 or 4 ft.

Booms are generally sectionalized and hinged to reduce width when moving between fields or on the highway. Two sections can be hinged at the rear of the tank and folded back; or, frequently, three sections are made with the middle section fixed, and the two outside sections hinged to swing

up or back. Outrigger wheels with a jointed boom will help keep the long boom parallel to the ground. When outrigger wheels are used for boom support, the booms and wheels may be made to swing back and trail behind the sprayer. Hinges or swivel joints can be purchased which will carry the liquid as well as turn, or a simple welded hinge can be made in the farm shop. Boom tips or the entire boom on one side may be hinged and held with a spring return. This adds an important feature, providing protection for the boom and objects that may be hit in passing by allowing the boom to swing back. When the welded hinge is used, it will block the ends of each section, making separate feeder hoses or hoses between the sections necessary. The separate feeder hose gives an advantage in control where valves on each section feeder can be shut off to enable the operator to use all or one or two of the sections at any given time. Liquid feed lines from the pump to the boom should be short and straight as possible and no smaller than the boom diameter.

Nozzles should be brought into the boom from the sides or top. This provides a settling space for dirt particles which may be flushed out if removable caps are placed on the end of the boom. This also keeps the boom from draining when the boom shutoff is closed. Nozzles may be brought into the bottom of the boom, using a nipple or coupling raised into the boom to provide the settling space. This has the disadvantage of obstructing the boom line, making it impossible to force rod cleaners through the boom from the ends.

SPRING-LOADED VALVES BETWEEN BOOM AND NOZZLES

Some operators are using spring-loaded valves between the boom and each nozzle which open when the boom pressure exceeds 5 psi and close below 5 psi. These are used principally to keep the boom from draining when the shutoff valve is closed, but they have the disadvantage of easily plugging and failing to shut off. A method recently introduced for stopping boom drainage and dripping is the reverse-flow valve system which places a suction on the boom and nozzles when the pressure is shut off and draws spray material from the nozzles back into the boom. The suction is obtained by discharging the flow from the pump through a Venturi or jet when the boom shutoff valve is closed. A 4-way valve makes it possible to combine the main boom control valve and the suction valve. Thus the two operations may be taken care of by one valve. This valve and Venturi assembly is patented and may be purchased from the manufacturer and installed on any sprayer.

Openings in the boom for the nozzles may be made by drilling and tapping the boom, screwing in a nipple or street elbow, and welding in place or by drilling the boom and welding a coupling over the hole. Welding is necessary to preserve structural strength. Suitable elbows and nipples are used to bring the boom outlet to the proper direction for the nozzles.

A relatively new type of applicator now being manufactured and used for many spraying jobs operates on the impulse principle, much the same as the whirling lawn sprinkler. Two nozzles are mounted on short arms and set at such an angle that the discharge of liquid from the nozzles causes the arms and body of the mechanism to revolve, throwing the spray in a large circle. The device is generally mounted in an inverted position on the end of a 10 to 15-ft pipe which carries the liquid spray. The pressure applied to the machine is in the range of 200 to 300 psi and causes the device to revolve at a much higher rate than the ordinary lawn sprinkler. This is necessary to increase the atomization of the liquid and produce the droplet size required. A swath of 20 to 30 ft is covered. This type of dispersal gives very little downward drive as compared with conventional sprayers.

Hand Booms. For fence rows, scattered weed patches, around buildings and in the garden, a hand boom with a knapsack or small power sprayer is very useful. Hand booms are also used with the large sprayer to cover small areas inaccessible to the fixed boom. The commercially made lightweight boom with one to three nozzles, quick shutoff valve and 25 ft of oil-resistant hose is the most satisfactory arrangement. Homemade booms can be made from pipe fittings but are heavy and clumsy if made from iron pipe. The best booms are made of aluminum or similar lightweight metals. The control valve for the hand boom should be placed between the hose and the boom. The most convenient type of valve is the spring-loaded, lever-operated, poppet style. Squeezing the valve lever against the boom with one hand opens the valve, which is closed by the spring when the lever is released.

Nozzles. Nozzles producing a flat fan-shaped spray are considered to give the most uniform coverage and strongest drive. Nozzles producing cone-shaped discharge are used in some cases for the extremely fine-sized nozzle (0.03 gpm and under used for low-volume, 2 to 5 gal per acre, 2,4-D work). The tip or orifice disk with either flat fan or cone-type discharge may be made an integral part of the nozzle, in which case the entire nozzle is changed to get a change in orifice size, or the disk may be removable by unscrewing a holding nut. Nozzles may be purchased with either male or female threads, usually ¼-in standard pipe size. Most nozzles, particularly the smaller ones, are provided with a built-in screen.

High pressures are not necessary for proper operation of the weed sprayer nozzles. It has been shown by tests that maximum pressures of 100 to 125 psi are fully as adequate as higher pressures and provide certain advantages in use: One is savings in equipment costs, because high-pressure equipment is expensive. Fogging and drifting are reduced because droplet size, which is a direct function of pressure, is reduced. With lower pressures, larger orifice openings at low pressure can be used to obtain the same discharge as fine opening nozzles at high pressure, thus reducing nozzle plugging and uniformity of discharge problems common to the very fine nozzles.

Most nozzles used for weed sprayers do not give a uniform droplet size but a band of sizes, as, for example, for a given nozzle at a given pressure, the band may be 10 to 150 microns (25,000 microns equal one inch). When the pressure is increased, the band of sizes shifts to the smaller end, decreasing the number of 150-micron droplets and increasing the 10-micron size. The range of particle size below about 50 microns is classified as an aerosol (airborne) and is increasingly subject to drift as the particles become smaller.

Penetration and distribution are a function of pressure with a given nozzle. Maximum penetration or drive is ob-

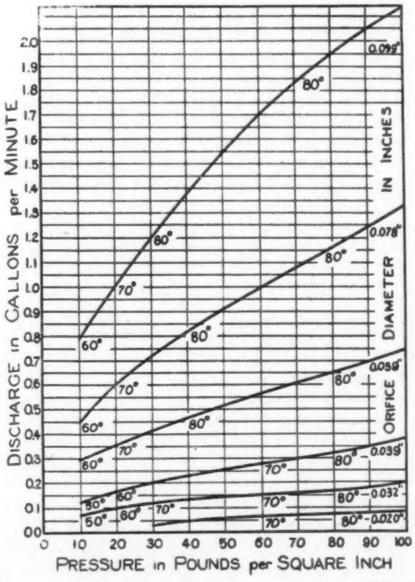


Fig. 5 Sample pressure-discharge curves of nozzles with different orifice diameters showing change in discharge rate with change in pressure. Figures under the curves show change of fan width with change in pressure

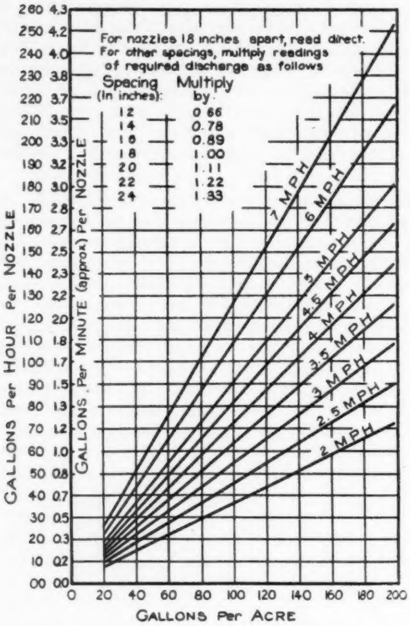


Fig. 6 This chart shows discharge per nozzle to give 2 to 20 gal per acre at various field speeds

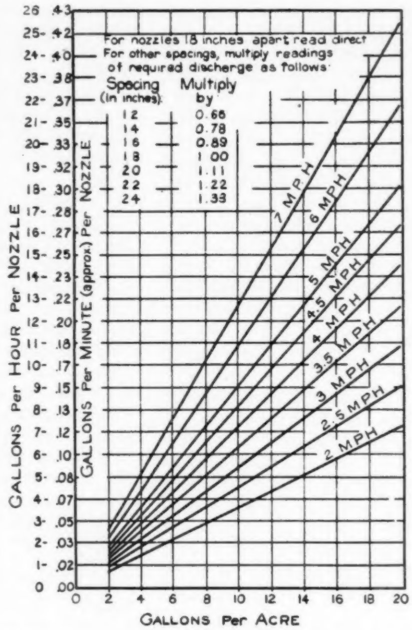


Fig. 7 This chart shows the discharge per nozzle to give 20 to 200 gal per acre at various field speeds

tained with large droplets at high pressure, but increasing the pressure on a given nozzle reduces the droplet size. Distribution is best with small droplets which cover the weeds most thoroughly, but the smaller droplets are more susceptible to drift. Thus a compromise must be made and an optimum pressure used which will give satisfactory penetration without serious drift.

The nozzle factors affecting optimum pressure are size of the nozzle orifice, design of the nozzle, and the physical characteristics of the liquid being discharged. Optimum pressure goes down for smaller nozzles; and for the 0.03 gpm size and under, the maximum pressure should not exceed 30 to 40 psi. Nozzles of different design made by the same or various manufacturers, even though they have the same orifice size, may have different optimum pressures due to the difference in droplet sizes they produce. The amount of suspended or dissolved material in the spray liquid and the amount, viscosity, and density of the oil used will alter the pressure characteristics. Increasing the amount of oil decreases the droplet size, all other factors remaining constant, and increases the discharge as much as 25 per cent when straight oil is used with a given nozzle.

High pressures, 75 to 125 psi, are generally used with water-base sprays, general contact spraying, heavy weed growth, and if fogging and drift will cause no harm. Lower pressures, 15 to 50 psi, will be used with oil sprays, 2,4-D or other translocated sprays, short weed growth, and in any case where fogging and drift might cause damage. Good judgment on the part of the operator is essential to determine the various influencing factors and decide in each case how the sprayer shall be operated.

Nozzle spacing on the boom depends upon the type of crop to be sprayed. When the outlets for the nozzles are welded into the boom, it may be necessary for specific row or bed widths to have extra outlets welded in which may be plugged to obtain other widths. Several manufacturers are using hose connections between the nozzles or to the nozzles from the boom to carry the spray liquid. Special nozzle holders which clamp on the boom may be moved for adjustable spacing. This system is particularly adapted to rows and beds where plantings are on different widths. For spraying row crops, it is customary to have one nozzle directly over each row, and the boom height is adjusted to allow the spray fans to meet between the rows. On bed plantings, the nozzles will be spaced to fit the rows on the beds. Nozzle spacing should be uniform for open field work, such as grain and alfalfa spraying, and may vary from 12 to 24 in.

The nozzle fan width and the spacing on the boom will determine how high the boom will have to be above the weed growth to have the fans meet at the tops of the weeds. Double coverage, where each strip of ground is covered by two nozzles, will give the most uniform and thorough application. This is particularly true in heavy wood growth, or when using contact herbicides, or when operating on rough ground where skipping may result when the boom height changes. Nozzles for double coverage are frequently arranged with alternate nozzles on opposite sides of the boom, and each row may be tilted slightly toward the other to get a different angle of attack. The fan angle is altered by pressure. That is, if a 0.15-gpm nozzle at 10 psi will give a 60-deg fan; at 80 psi, the fan may be 70 deg; and at 100 psi, 80 deg. When ordering nozzles, the manufacturer's catalog on the nozzles used should be consulted for fan angle, as well as discharge volume for a given pressure. Figs. 3 and 4 indicate the relationship of boom spacing, fan angle, and convergence height. For example, with 18-in nozzle spacing on the boom, the 60-deg fans converge or meet at a height of 15½ in. Also, double coverage will occur if this 60-deg fan is raised to 30 in.

The exact spacing of the nozzles on the boom for field spraying will be chosen by the operator. Since, however, the boom must be kept as low as possible for all applications, short spacings (12 to 18 in) will be used for the double coverage system or for low-volume application, since the low volume nozzles in either fan or cone discharge produce a narrow fan at the pressure used. Wider spacings (18 to 24 in) will be used with wide fan angle nozzles (80 to 100 deg) which are common with medium to high discharge and pressure or with single coverage application.

Calibration of the Sprayer. The calibration of the sprayer consists of determining the gallons per acre the sprayer discharges under the variable conditions of (1) ground speed, (2) nozzle pressure, and (3) size of nozzle orifice. Nozzle spacing must also be considered when the first calibration is made or if the spacing is altered at any time. Any or all of these factors may be altered to obtain the desired volume coverage. Another variable may be used in mixing the spray material when it is possible to alter the ratio of toxic ingredient to diluent.

The small hand-boom power sprayer or the knapsack sprayers may be calibrated roughly by measuring the volume discharged in a given length of time. By determining the output of the hand boom in gallons per minute with several settings of pressure and with different nozzle sizes, an approximation can be made of the length of time which must be spent in covering a given area to a predetermined gallonage per acre.

The large power sprayer must be calibrated as closely as possible so that the operator can choose the correct values for the three variables to produce the required volume in gallons per acre. Orifice or nozzle size offers the greatest variable of the three factors. Pressure should be held within the limits recommended for the type of application and crop, and

ground speed will depend upon the tractor used and the roughness of the ground. Commercial weed sprayers frequently use ground speed indicators or speedometers of an accurate type, and some also use discharge meters to assist them in making accurate applications.

The correct nozzle or orifice size for a given set of conditions involving gallons per acre, ground speed, nozzle pressure, and spacing can be determined by consulting data provided by the nozzle manufacturers. This information can also be obtained from charts such as shown in Figs. 6 and 7 (or working these figures out mathematically) and the nozzle catalog. The charts prepared by the nozzle manufacturers frequently give gallons per acre directly for a series of field speeds, pressures, and nozzle sizes. A chart is prepared of these variables for each nozzle spacing. Fan width information may be on these charts or included as separate information. Nozzles having the same orifice size but made by different manufacturers may not have equal discharge rates at a given pressure; thus the nozzle charts or discharge rates for the specific nozzles to be used must be consulted.

The charts, Figs. 6 and 7, have been prepared to show these relationships irrespective of the brand of nozzles used. Fig. 6 is for relatively low volumes, 2 to 20 gal per acre, while Fig. 7 gives data on 20 to 200 gal per acre applications. These charts are used to find the gallons per minute discharge from a single nozzle. The nozzle manufacturers' catalogs for the type nozzle to be used are then consulted to determine the correct nozzle size.

For example, the problem is given to spray 50 gal per acre at 4 mph with nozzles spaced on the boom (swath width for one nozzle) 18 in or 1.5 ft. The pressure recommended is to be between 40 and 80 psi. Fig. 7 is consulted, and the 50 gal per acre point is found on the scale at the bottom of the chart half way between 40 and 60. This is followed upward to the intersection of the diagonal curves to the 4-mph line; then across to the left to the gallons per minute scale which indicates about half the way between 0.5 and 0.7, or 0.6 gpm. If the nozzle spacing were 12 in instead of 18, the 0.6 gpm would be multiplied by the factor 0.66 as shown at the top of the chart, and would indicate 0.4 gpm.

This information, along with the pressure, is taken to the catalog and the nozzle which will give close to 0.6 gpm (or 0.4 gpm depending on the nozzle spacing) with a pressure between 40 and 80 psi will be chosen.

INFORMATION CAN BE WORKED OUT ARITHMETICALLY

The information in the charts can be worked out arithmetically. For the problem above, the equation, gallons per acre $\times$ nozzle spacing feet $\times$ mph $\times$ 5,280/43,560 $\times$ 60 = gallons per minute.

Fig. 5 is a sample chart of a given brand and type of nozzles showing relation of pressure to nozzle discharge and fan width and would be used to convert the gallons per minute per nozzle found from Figs. 6 and 7 to a specific nozzle size. For the example worked out, Fig. 5 shows that for 0.6 gpm (left scale) and 40 to 80 psi (bottom scale), the nozzle with orifice diameter 0.059 (numbers on right identify nozzle curves) would be used.

Nozzle discharge information in the manufacturer's catalog may be presented by curves such as Fig. 5 or tables covering discharge and fan widths over a wide range of pressures. Most nozzle manufacurers identify their nozzles by the orifice diameter or by the gallons per minute or hour discharge at a given pressure. In some cases the identifying code number also includes the fan spray width at the same pressure.

The height at which the boom should be placed is given in Fig. 4. The fan width at given pressure is taken from the manufacturer's catalog and used with the nozzle spacing to find the correct boom height for either single or double coverage. This can readily be checked by observing the sprayer in action, and the boom should then be raised or lowered if change is necessary.

For small variations in gallons per acre applied, the pressure and machine speed can be altered using the charts of Figs. 6 and 7 as a guide. Where large variations in coverage are needed, the nozzle orifice size must be changed.

After the nozzles have been chosen and installed, an accurate check on the discharge can be made by measuring the actual discharge of spray mixture from one nozzle in a pint or quart bottle or graduated glass. If the time required to run off a certain volume in the bottle is taken, then gallons per minute discharge can be measured. The tractor speed can be found by finding the time required to proceed a given distance; thus the gallons per acre can be accurately determined.

This analytical method may not be necessary except for the low-volume sprayer. A rough check on the gallons per acre can be made in the field during the first two or three rounds by determining the acres covered in a round and accurately measuring the amount discharged by the amount required to refill the tank or by calibrating the tank. Some variation in the nozzle discharge rate as given in the manufacturers' catalogs will be evident because of the difference in physical properties of the spray solution used and water with which the nozzles are calibrated. As mentioned before, adding oil increases the discharge rate; while adding suspended or dissolved materials decreases this rate.

Equipment Design for Weed Control

(Continued from page 383)

The interest in weed-spraying equipment brought about by the development of 2,4-D is probably only a beginning. New chemicals are on the way, and the weed control problem is certainly headed for some major changes. The equipment design problems are many—some solved, many not solved. The American Society of Agricultural Engineers should schedule programs on the subject at future meetings and act as a clearinghouse for data and information.

A Correction

IN the article entitled "Results of Irrigation Research in Georgia—Part II," by John R. Carreker and W. J. Liddell, (page 302) which appeared in AGRICULTURAL ENGINEERING for July, 1948, the references to the fumigants used for nematode control should have read as follows:

(1) Dichloropropane-dichloropropylene, distributed by Shell Chemical Corp., under the trade name "D-D."

(2) Dichloropropane-dichloropropylene, distributed by Dow Chemical Co. under the trade name "Dowfume N."

(3) Ethylene dibromide, distributed by Dow Chemical Co., under the trade name "Dowfume W-40."

Implications of Technical Progress

PERHAPS the single most important reason for studying technological change is to afford society a mechanism for predicting the social changes which are expected to occur, and to formulate such policies as circumstances may seem to warrant. For change in itself is disconcerting, notwithstanding the fact that the American people pride themselves on their so-called desire for the "newest" and "latest." Change is often considered "bad" for no other reason than that it is change. Hence, any thinking that will permit a society to better adapt itself to the inevitable changes which will occur—changes stemming in large measure from technological innovations—will be better able to meet such changes.

Specific discussion and "planning" are called for with respect to the areas previously described. By "planning" is meant only achieving full cognizance of the ultimate developments in a given area, and evaluating them in the light of society's values. Thus, it is possible for the "planner" to predict that such and such will occur, and that various alternative action programs are possible, depending on the ultimate goals or values of society. If and when society adopts some ultimate goal, then that program can be implemented which will most closely fit impending changes to such goal. This is not to say, however, that goals and values will necessarily be decided on a conscious, rational basis, but rather that every society definitely does have values, and these values often change with the passage of time.—*From "Technological Innovations and the Changing Socio-Economic Structure," by A. J. Jaffe in "The Scientific Monthly" for August, 1948.*

Field Spraying Equipment for Weed Control

By W. P. MacDonald

SINCE the introduction of practical selective herbicides in the United States approximately 10 years ago, there has been a tremendous development in the spraying equipment field. It would not be factual to say that all problems have been met and that sprayers suitable for farm use have been perfected. No one should be offended if it is stated that, in this particular instance, the botanists and chemists are still ahead of the engineers.

The modern use of selective chemicals dates back to the end of the last decade. Prior to that time many attempts had been made to control weeds in growing grain. Some of these attempts were remarkably successful. In general, however, the inconveniences and expenses involved precluded any widespread use of the chemicals available. Such materials as sulphuric acid and iron sulphate were successfully demonstrated in the upper Midwest approximately 50 years ago. Doubtless the history of the use of these and other products dates back much further. It was unfortunate that the nature of the chemicals made them unsuitable for general use.

In the middle 1930's, a Frenchman observed that certain dinitro compounds had value as selective herbicides. In 1938 or 1939, rights were granted for the manufacture and distribution of one of these products in the United States. In this country the chemical was sold under the trade name of "Sinox", and the first record we have of its general use on farm crops was in California in 1939. To our knowledge, it was first used in the spring wheat area on a demonstrational basis in 1940. Some very sensational results were apparent in these demonstration plots.

As a result of observations on the demonstration plots, a few farmers decided that they should have sprayers for their own use. It is true that at that time a number of very good sprayers were being offered commercially. The difficulty was that these sprayers had been developed for other purposes, principally for the application of insecticides and fungicides to row crops. They were strictly specialized pieces of equipment, they were not produced in volume, and they had many features which did not appear essential to the application of dinitro weed killers. Most of them were equipped with expensive, high-pressure, low-volume pumps. It seemed at the time that much less elaborate equipment could be used for the application of sinox. The result was that a few farmers set out to build their own equipment, with or without technical assistance. Each individual had his own conception of what a satisfactory sprayer should consist of. There was as much difference in the sprayers which resulted, as in the personalities and bank accounts of the builders. Tanks used in the construction of the machines had to hold water and be available locally, for a price. Some were steel, others wood or galvanized iron. In view of the fact that the sprayer had to be designed for the application of 80 to 100 gal per acre, big tanks were needed. Capacities in general ranged around 500 gal, but there were some as large as 1,500 gal. One of the latter size was mounted on a track type running gear.

This paper was presented at the annual meeting of the American Society of Agricultural Engineers at Portland, Ore., June, 1948, as a contribution of the Power and Machinery Division.

W. P. MACDONALD is manager, agricultural department, F. H. Peavey & Co., Minneapolis, Minn.

This sprayer has a 125-gal tank, 33-ft boom, brass gear pump, and is powered by a 1½-hp, air-cooled engine. Several thousand of these machines were used in the Dakotas and Minnesota this season

Every type of pump that would move water was tried. Often the source of power was an engine taken from the farmer's combine. In other cases power was obtained by power take-offs and one-cylinder, water-cooled engines. As recently as ten years ago, air-cooled engines were not readily available, at least not in the upper Midwest, and in any event the farmer, however optimistic he may have been about chemical weed control, had sufficient doubts to dissuade him from making an appreciable cash outlay for his sprayer.

Booms on these sprayers were of every kind and size. In length they ran from 30 to 80 ft. One individual started to build a sprayer designed for a 120-ft boom, but the project kept getting bigger and bigger and we are not sure that it was ever finished. Very little use was made of flexible hose on these early machines and the pipe connections and arrangements would provide a nightmare for an experienced plumber.

In spite of an alarming lack of technical information, both as to the construction of sprayers and proper use of the chemical involved, results for the most part were good, even the first season. It is a fact that nearly all of the operators who used ground equipment for the wet application of selective herbicides eight or nine years ago, are still following the same practices, although the equipment and chemicals they used have almost completely changed.

A natural area for the use of selective chemical weed killers is the northern Red River Valley. The Red River is boundary between North Dakota and Minnesota, and the river valley has soils that are famous for their fertility. Normally rainfall is sufficient to produce crops regularly without the necessity of summer fallowing to conserve moisture, yet at the same time the season is too short to permit the economical use of corn or other intertilled crops. It is true that this area produces a considerable acreage of sugar beets, but their production is limited to farms within a reasonable distance from the factories. There is also a large acreage devoted to the production of certified seed potatoes, but the majority of the farms do not have an intertilled crop which would assist them in combating weeds. Summer fallow then is practiced only for the purpose of weed control. Reluctance on the part of the operators to leave good land idle for a year in order to control weeds, has resulted in a considerable problem with broad-leaved annual weeds, particularly those of the mustard family. Farmers were quick to appreciate that, if these weeds could be controlled with selective chemicals in the growing crops, the productive acreage of their farms could be increased 10 to 20 per cent.

Following the experiences in 1941, a few more farmers in 1942 built additional sprayers, more or less to a pattern. More followed the trend in 1943, and in 1944 two machine shops recognized the demand and built a total of about 45 sprayers. In 1945, one of the manufacturers dropped out and the remaining company built approximately 75 machines. This number was doubled in 1946 and increased to 500 units for use in 1947. Totaling up the known production, we find that there were approximately 800 sprayers available for use on the 1947 crop. Keep in mind that while these machines varied greatly in construction, they were all designed to apply solutions

at from 75 to 100 gal per acre.

By the 1947 season, other dinitro compounds had appeared on the market and farmers as well as research men did considerable work in 1946 with limited quantities of 2,4-D. In December, 1946, the annual meeting of the North Central Weed Control Conference was held in Des Moines, Iowa. The general recommendation that came out of this meeting suggested the use of 2,4-D and dinitro chemicals in solutions applied at from 80 to 160 gal per acre. However, at this gathering a research worker from the southern gulf area pointed out that with aircraft successful control of certain aquatic weeds had been obtained on lake margins with applications of straight 2,4-D formulations without the use of any diluent. This naturally suggested that using upwards of 80 gal of solution per acre might not be necessary for successful applications of 2,4-D with ground equipment

Early in 1947, our company concluded that tests with low-volume applications of 2,4-D should be accomplished at the earliest possible moment. Consequently we arranged for a series of winter tests in the Sacramento River Valley near Davis, Calif. On these tests we had the pleasure of working with W. W. Robbins, A. S. Crafts, and W. A. Harvey of the botany department and O. C. French of the agricultural engineering department of the University of California. These tests were not intended to determine the effectiveness of 2,4-D as a weed killer, or to indicate crop tolerance. The only objective was to learn if the chemical could be distributed as uniformly and effectively with low volumes of water as with high gallonages. Using a constant amount of chemical, the volume of solution ranged from 1½ to 108 gal per acre. Suffice it to say that subsequent observations indicated entirely comparable results at both of the extremes and all intermediate rates. This information was available in March, 1947.

LOW-VOLUME NOZZLES RECOMMENDED TO OPERATORS

Returning to our own area, we recommended that the several hundred operators, who had provided themselves with machines for use in 1947, obtain low-volume nozzles. Nozzles which would provide a rate of approximately 10 gal per acre with a 26-in boom spacing were suggested for use with the sprayers available. An even lower rate per acre would have been recommended, but lower volume nozzles were not available in quantity. Late in the 1947 season, we obtained written reports from over 250 farmers who had used the 10-gal-per-acre rate. These operators reported even more satisfactory weed control than those who used over 10 gal per acre. To further confirm the value of low-volume spraying, an elaborate series of tests was conducted by our company in three spring wheat states last season in cooperation with the USDA Bureau of Plant Industry, Soils and Agricultural Engineering, and several state experiment stations. The lowest volume per acre rate used was 2½ gal and the highest 80 gal. Identical weed and crop reaction was obtained at all rates.

The preceding paragraphs may appear to be a digression from the subject assigned, but are believed to be important to establish the fact that we now have chemicals suitable for low-volume application, which method has obvious advantages to the farmer. It is for agricultural engineers to design equipment which will satisfactorily do the job.

This season we handled the distribution of several thousand field sprayers designed for the application of 2,4-D at the rate of 5 gal per acre. By and large these machines gave good performance. Certainly our experiences in 1948 will result in better equipment next year. Some of the difficulties encountered during the past season could not be attributed to the equipment, but must be the responsibility of industrial chemists. Field experience developed the fact that not all 2,4-D formulations are precipitate-free when used in high concentrations with the hard water common in the Midwest. The precipitate resulted in clogging of low-volume nozzles. That is a problem for the chemists.

Now let me ask, What constitutes a good sprayer for the application of selective herbicides? First of all, in order to have a sprayer we must have a tank, a boom, a pump, and a source of power. These integral parts must be assembled and provision made for moving the equipment in the field. In our area three general types of sprayers have been operated. These are machines mounted on their own running gear, those which are skid mounted, and those designed as an attachment for mounting on tractors or jeeps.

The tractor-mounted sprayer has an advantage in that it is strictly a one-unit, one-operator machine. When mounted on a row-crop tractor, it has high clearance which adapts it to a wider range of crops. As it is driven from the tractor engine, there is an ample and dependable source of power. The single unit makes only one set of tracks in closely drilled crops. For the most part, tractor-mounted sprayers represent a smaller initial investment for the farmer than do other types. It is also true that most tractor-mounted sprayers provide for the boom mount ahead of the tractor which is a convenience for the operator.

The principal disadvantage of the tractor-mounted sprayer is the inconvenience involved in putting it on and taking it off the tractor. Quite frequently the farmer has a small patch of weeds which need attention. Perhaps at that particular time he has his row-crop cultivator mounted on the tractor. To spray, it is necessary for him to remove his cultivator, mount his sprayer, and after spraying he must remove the sprayer and remount the cultivator in order to get back to his corn. All too frequently under these circumstances, the weeds do not get sprayed. The matter of carrying water on a tractor-mounted sprayer has also been quite a problem.

THE TRACTOR-MOUNTED SPRAYER PRESENTS A PROBLEM

It is true that no one make and model of tractor presents much of a problem, but when the manufacturer tries to design brackets suitable for use with his sprayer on all makes and models of tractors, he meets with some difficulty. While having the boom ahead of the tractor may be considered an advantage for post-emergence spraying, it would seem to be a disadvantage if pre-emergence spraying comes into favor. Disturbing the soil surface after pre-emergence spraying appears to defeat the purpose of the operation.

Skid-mounted sprayers, while usually higher in price than tractor mounts, are generally priced lower than those provided with a running gear. Many farmers are now equipped with rubber-tired trailers of various types suitable for use with skid-mounted sprayers. These machines may also be used with most types of farm trucks and pickups where a tractor is not available. It is generally not very satisfactory, however, to use equipment built for road use at low speeds on soft ground — at least not on extensive acreages. It is also true that the rate of speed of such equipment is difficult to control properly. With skid-type sprayers the booms are generally mounted behind the unit which has the advantages or disadvantages previously mentioned. If this type of sprayer is mounted back of a truck cab, the driver has little opportunity to observe operation of the boom when traveling.

The third general type of sprayer is the trailer unit. These machines provided with their own running gear have an advantage in that they may be pulled by any type of traction equipment. There is a big convenience in being able to simply drop in a coupling pin to attach the sprayer. Having the tank mounted so that it is mobile does away with lifting and moving awkward assemblies. Booms may be mounted either ahead or behind the sprayer proper, but must be mounted behind the tractor, or other power. One disadvantage of the trailer machine is that the initial cost is higher. Having extra wheels on the ground may also result in greater crop injury, particularly if the crop is in an advanced stage of growth and the sprayer does not track with the tractor. In general, however, we have not felt that wheel track damage is significant where the soil is fairly firm and the crop is sprayed at the proper time.

Many variations of these three general types of spraying equipment have been used in our area. By and large, we believe that farmers prefer trailer-type sprayers when the price can be kept at a reasonable figure.

It would probably be in order to discuss separately the

specifications of the several assemblies that go to make up a sprayer.

The tank must provide sufficient capacity to permit covering a considerable acreage without refilling, yet not be so heavy when filled as to be cumbersome or difficult to move on ordinary fields. If 5 gal per acre is considered a standard for 2,4-D, then the tank should probably have a minimum of 50 gal and a maximum of 150 gal capacity. If dinitro chemicals are used, more water capacity is required as these chemicals generally require that the solution be applied at upwards of 40 gal per acre. A 100-gal tank at the 5-gal rate will permit spraying 20 acres without refilling. At 40 gal per acre, with a 400-gal tank, only 10 acres can be covered.

Prior to 1948, most all tanks were made of steel with a few of wood construction. This year a majority of the sprayers have aluminum tanks. So far aluminum seems to be a good material in that it is not subject to corrosion. Of course, aluminum is a difficult metal for the average farmer or small machine shop to work on if repairs are needed.

The shape of a tank is not particularly important, but there should be a minimum of sharp angles and corners which may collect foreign material. Consideration must be given to distributing the weight when the unit is assembled on trailer mounts. The center of gravity should be kept as low as possible. It is important that tanks be built of materials that do not easily corrode. That problem may be rather difficult to overcome as there is such a variety of new agricultural chemicals being offered. Their action on metals has not been fully determined when used alone or in combination. An agitation system effective throughout the entire tank is certainly desirable and for the use of wettable DDT an adequate agitation system is an absolute essential. Provided the pump has sufficient volume, it is a relatively simple matter to provide a by-pass whereby the excess flow from the pump can be returned to the tank for agitation. The tank should have a large fill opening to permit cleaning, and the outlet from the tank should be so located that it can be completely emptied either by the pumping system or gravity flow. Some provision should be made in the fill opening to screen the liquids as they are put into the tank.

BOOMS SHOULD BE OF NON-CORROSIVE MATERIAL

In our area most of the booms run from 24 to 40 ft in length. A few operators on flat land with large fields are using booms up to 80 ft. For low-volume applications where small nozzles are used, it is important that the boom be constructed of non-corrosive material. Most of the booms in use this season were made of iron pipe or steel tubing. Such booms will generally perform satisfactorily the first season, but rust increases nozzle clogging as the machines become older and proper care is required. From the standpoint of corrosion, aluminum is a good metal, but it is difficult to repair. Brass booms are satisfactory, but are considerably more expensive. In some cases a frame has been constructed as a support for rubber tubing which carries the liquid. This does away with the problem of corrosion, but the tubing may deteriorate and hose connections are always a problem. Regardless of the material from which a boom is constructed, it must be strong and light.

Provision must be made for collapsing the boom for the convenience of the operator when moving between fields or to his source of water. Several sprayers this season had two-way action swing joints which prevented breakage when the boom struck an obstacle. This feature has its place, but may add unnecessarily to the cost of construction. It should not be a difficult matter to provide a safety device for such eventualities which would simply release the boom to prevent breakage. The operator could stop the machine to replace the boom in its proper position. Most machines have the boom suspended from the frame by cables, chains or rods, and it is held at right angles to the line of travel by a similar arrangement. Such suspension is generally satisfactory, but sometimes on an otherwise level field one of the wheels of the unit may be following a deadfurrow. This results in the boom being carried at an angle and may even cause the low end to run into the ground. This difficulty may be overcome

This picture shows a partially sprayed spring wheat field near Nielsville, Minn. To the right is the sprayed area, and on the left is the unsprayed area showing a luxuriant growth of yellow mustard. Spraying this field resulted in an increase of 5 bu per acre and 1½ lb test weight wheat

by a leveling device, and in some cases caster wheels have been put on the boom to carry the weight and follow the contour of the ground. With booms that are 24 ft or more long, some means should be provided to operate one-half of the boom independently of the other.

Nozzles are generally placed with a 15 to 22-in spacing on the boom. The nozzle spacing naturally depends on the height at which the boom will be operated. Close spacing allows the boom to be carried lower but, with any given nozzle size, increases the volume applied. Greater distances between nozzles require that the boom be carried higher and reduce the volume per acre. Of considerable importance when using 2,4-D is the factor of drift. Drift increases as the boom is raised higher. Taking the problem of drift into consideration and keeping in mind that low volumes are desirable, a 15 to 18-in nozzle spacing would seem to be satisfactory for small grain. A 20-in spacing is preferred for corn. To meet the present demand nozzles should apply 5 to 10 gal per acre with this spacing at 30 to 50 lb pressure and normal tractor operating speeds.

Practically all of the weed-spraying nozzles used in our territory produce a flat, fan-type spray with a 70 to 90 deg angle. Nozzles must be noncorrosive and brass seems to fit this requirement. They must be simple and easy to clean. They should throw a uniform pattern at minimum operating pressure. For low-volume spraying, the nozzles must be individually screened. The mesh of the screen used should be sufficiently fine that foreign material passing through the screen cannot clog the nozzle orifice. Probably the screen mesh should not be over 25 per cent as large as the nozzle opening. Screens should be screwed or snapped into place in the nozzle as screens held in place by friction alone are very apt to bounce out. Under some conditions it may be desirable to have nozzles that shut off immediately, and, in this case, spring and ball shutoffs should be installed on each nozzle. Where such shutoffs are not provided, pressure in the boom will result in a continuation of the spray for a half minute or so after the pressure has been shut off at the pump. As a substitute for shutoff valves on each nozzle, one machine has been developed which provides a reverse suction on the boom. This arrangement immediately empties the boom when the valve is changed.

Pumps which provide pressures of from 30 to 50 psi appear to be entirely adequate for use with herbicides. Most farmers, however, want a machine that can be used for other purposes. For general farm use of DDT, a pump that will develop up to 100 or 125 psi is preferred. Pressures in this range have given good fly control on both livestock and buildings. Some adjustment must be provided so that the pressure will remain constant at the desired point. An accurate pressure gage is essential. This gage should be located between the boom and any strainers that are in the line.

All types of pumps are being used. Probably the majority of the sprayers are equipped with brass-gear pumps, but good success has been obtained with several types of

rotary, centrifugal and rubber-paddle pumps. With brass-gear pumps, or others, where the tolerances are close, abrasive foreign material in the water cuts the pumps out quickly. Otherwise gear pumps are very nearly foolproof. Centrifugal pumps give good spraying pressure, but do not prime readily. Rubber-paddle pumps are not particularly affected by abrasives in the water, but may be quickly damaged if they are run dry. Generally speaking, the rubber pumps develop only a minimum of pressure. Whatever pump is used, it must be simple, quick priming, designed to hold steady pressure, and give long service in all kinds of water. Pumps which can be coupled directly to the source of power have an advantage in that there are fewer moving parts and the safety factor is increased.

It is unnecessary to go into any detail with regard to power requirements. Most of the trailer-type and skid-type sprayers are now equipped with air-cooled engines capable of furnishing sufficient power to do the job. A 1½-hp, air-cooled engine will provide adequate power to handle a 32 or 40-ft boom when the volume is around 5 gal per acre. Where the power is derived from tractor power take-offs, some improvements need to be made to meet minimum safety standards.

Most buyers now want a sprayer which is provided with a coupling for attachment of a hose and hand gun. This permits weed control in fence corners and other areas that cannot be reached with a boom. With such a hand gun provided, it is also possible for the farmer to spray livestock and buildings.

USE OF PROPER STRAINERS IS IMPORTANT

Only passing reference has been made to the use of strainers or screens in booms. In this connection, we would say that regardless of the amount of screening provided, the operator will cover more acres if only clean water is used. Strainers have but one purpose and that is to remove foreign material. If dirty water continues to be introduced into the machine, strainers are certain to plug up if they are serving their purpose of removing dirt. Certainly a strainer of some sort should be provided on the intake hose, and probably it is necessary to use a second strainer in the suction line or where the water enters the tank. Individual strainers in the nozzles are required. Fine brass or Monel screens of 80 to 200 mesh, with the finest mesh in the nozzles, seem to be most satisfactory.

Some mechanical device or chemical needs to be developed to mark the area sprayed satisfactorily. When an almost colorless solution is applied at low volume, the sprayed area is not discolored and, as a matter of fact, is scarcely wetted. Any lapping that occurs results in double application which may be harmful to the economic crop and in any event is wasteful. If someone will develop a good system for marking, he will be doing a real service to sprayer operators, and, incidentally, should make himself some money.

Proper calibration of sprayers is very important. From the practical standpoint, it doesn't do the farmer much good to know that the sprayer he purchased will apply 5 gal of solution per acre at 30 psi and 4 mph, if he doesn't know how fast his tractor moves with the kind of load he will be pulling. We believe that every sprayer should be calibrated in the field under conditions similar to those that will prevail when actually spraying. Sprayer calibrating devices have been offered which will do a good job if properly used, but generally depend on the results obtained with one nozzle, which may not truly reflect the performance of the entire boom.

It goes without saying that field sprayers must be built to withstand abuse. Operators who are content to plow at 3 mph apparently become so fascinated by the miracle of selective weed control that they will attempt to pull their sprayers 8 or 10 mph over the roughest land on the farm.

As a final observation it seems that, though remarkable progress has been made in the last two or three seasons, there is need for improvement in the construction of farm sprayers. We have the chemicals to work with and the perfection of spraying equipment will present no lasting problem to this group which has contributed so much to agricultural efficiency in recent years. With improvements in design and given greater durability there will be a sprayer on every farm in the grain-growing area.

Plastic Garden Hose

By C. N. Johnston
MEMBER A.S.A.E.

GARDEN hose made of an homogeneous plastic material without the aid of internal cotton or other fiber reinforcing, has been available for several years. It is claimed by the manufacturers of this product that it will carry more water for a given hose size than the pioneer rubber hose. Tests reported herewith on ¾-in plastic and rubber hose indicate that the claim of greater capacity for the plastic hose is substantiated.

Tests were run on ⅝-in and ¾-in plastic hose in two 50-ft and single 100-ft lengths for both sizes and a comparison check was made on two 50-foot lengths of ¾-in rubber hose. During the tests a calibrated meter recorded throughput, and pressure drop was indicated on a mercury manometer. The hoses were kept as straight as possible, so readings are for ideal conditions. Casual inspection of the terminal connections on the two sizes of plastic hose and the rubber hose disclosed a design difference in their terminals. The all-plastic hose had a heavy brass ring outside the hose at the end and the attachment was made by forcing a lighter brass sleeve out against the plastic and indirectly toward the heavy outer ring. The two black 50-ft rubber hose had couplings in one case like those of the plastic and in one case very different. This exception had a heavy inner brass casting and a light outer shell crimped around the hose compressing the hose against the inner casting. These heavy inner castings restricted the inlet and outlet to this hose noticeably as compared with the other hose ports. This latter rubber hose will be identified hereafter by the name "constricted inlets."

As might be expected, the ⅝-in hose delivered less water than the ¾-in, but it is interesting to note that the two 50-ft pieces of ⅝-in did as well as the single 100-ft length. The couplings had no effect on the flow. In contrast, the two 50-ft lengths of ¾-in plastic hose gave more loss than the single 100-ft length of that size plastic. The two 50-ft rubber hose, when compared with a 50-ft length of ¾-in plastic hose, indicate that one gives less head loss and one more than the plastic check. The surprising thing here is that the rubber hose with the constricted inlet shows the least loss. Since this unexpected result could not come without some physical or structural cause, it was decided to check to see if the differences came from actual variances in the internal diameter (ID) by checking the internal volume of each 50-ft section. These volumes, in cubic centimeters, were: plastic, 3750; rubber, (open entrance), 3420, and rubber (constricted entrance), 4538.

These figures indicate the ¾-in plastic hose had a volume intermediate between the two rubber hose. Because the lengths were identical, the cross-section areas vary in direct relationship to their volumes. This fact probably accounts for the higher throughput of the constricted entrance rubber hose length. If the friction loss for the plastic is similar to that of the rubber hose, the three hose being compared should provide data on a reasonably straight line if we plot throughput at any given pressure drop against internal volume. The plastic hose plots to the right of what would be a straight line joining the location of the points for the two rubber hose, indicating the plastic under test did deliver more water for a given head loss than the rubber of identical internal dimensions. The constricted outlets of the large ID rubber hose must have caused a notable share of the recorded losses for the hose. If it were equipped with better designed inlets, the apparent margin of efficiency of the plastic over rubber as indicated from these test data, would be reduced.

This paper was prepared expressly for AGRICULTURAL ENGINEERING.

C. N. JOHNSTON is associate professor of irrigation and associate irrigation engineer in the experiment station, University of California (Davis).

EDITOR'S NOTE: More detailed data on test results are available from the author to engineers particularly interested.

Evaluating Soil Losses from Field Areas

By D. D. Smith and D. M. Whitt
MEMBER A.S.A.E.

A RATIONAL erosion equation has been developed by which probable soil losses from field areas can be calculated. Its principal use has been in applying erosion control measures to the land and in checking the adequacy of conservation farming plans in controlling erosion. It was used last summer as the basis for estimating the erosion damage in north Missouri caused by the flood-producing rainstorms of May and June. In this case, the calculated soil loss on the cultivated land averaged 28 tons per acre. The results of a cooperative field survey completed a few weeks later indicated the loss as 30 tons per acre.

This method of calculating field soil loss has been referred to as the factor system. The approach is rational and not theoretical, as such an equation would be too complex for practical use, even if it could be derived and the constants evaluated. The basis for the system was established by Zingg[7]* and applied by Smith[4] in papers published in 1940 and 1941. Further application was made by Browning[1] and others working in Iowa. Two additional papers on the subject were presented at the 1947 meeting of the American Society of Agronomy[2,6].

The principal factors affecting field soil loss are: cropping systems, with their related cultural methods and soil treatments; land slope, per cent and length; soil, with its physical, fertility, and erosion variations; rainfall amount, rate, and distribution; and supporting conservation practices, including contour farming, terracing, and strip cropping.

Cropping has been the big factor causing high rates of erosion and, by means of proper crop sequence, the tool by which much has been accomplished in control of erosion. This is illustrated in Fig. 1. Cropping systems alone have not been enough for the safe growing of grain and cultivated crops on sloping land. Because of the wide cropping variations possible and limited funds available for research, it has been necessary to study this factor on small fractional-acre plots with only a meager checking on larger field areas. The application of data from these small plots to the larger field areas requires adjustment of the slope, soil, and supporting practice, variables of the plots to those existing in the field. This is accomplished by the rational equation. It is as follows:

$$A = CSLKP$$

in which A is the average annual soil loss in tons per acre

C is the average annual rotation soil loss from plots in tons per acre

S, L, K, and P are multipliers to adjust the plot soil loss C for per cent land slope, length of land slope, soil group, and supporting conservation practice, respectively, when their field values are different from their plot values.

The addition of a rainfall adjustment factor to the equation would be required for application of the method over large areas (several states). However, when the values of C are measured toward the center of a rainfall-intensity area of limited variation, inclusion of the factor is not required. This is the case for Missouri when data from the Missouri Soil Conservation Experiment Farm at McCredie are used.

This paper will present the factors used in the erosion equation without a detailed discussion of how they have been secured as these details have been covered in other articles either published or to be published at an early date (refer to literature citations).

Crop Factor, C. An intensive study of cropping systems including most of the common Missouri crops grown in different sequences has been conducted at the Missouri Soil Conservation Experiment Farm since 1940. These studies have shown the sequences for corn, soybeans, and grain crops that will result in the least erosion. Losses have been measured for 12 different rotations, and calculated by use of the sequence data for numerous others. The plot soil losses for nine of these rotations are shown in Table 1. These losses are less than would occur on field areas with slopes longer and steeper than those of the plots. Soil treatments to enable the crop to grow vigorously are of course a prerequisite for the systems as otherwise higher losses would occur.

TABLE 1. AVERAGE ANNUAL SOIL LOSS IN TONS PER ACRE FOR DIFFERENT ROTATIONS ON PLOTS OF 3 PER CENT SLOPE, 90 FT LONG, AND FARMED UP AND DOWN SLOPE*

No.	Rotations	Soil loss tons/acre †	‡
1	Wheat — grass and legume meadow, 3 yr	0.6	0.7
2	Wheat — grass and legume meadow, 1 yr	1.0	1.1
3	Corn — oats — grass and legume meadow, 3 yr	1.6	1.8
4	Soybeans — wheat — grass and legume meadow, 1 yr	1.9	2.1
5	Wheat and lespedeza (both grazed)	2.3	2.5
6	Corn — oats — grass and legume meadow, 1 yr	2.4	2.6
7	Corn — soybeans — wheat — grass and legume meadow, 1 yr	2.9	3.2
8	Soybeans — wheat and sweet clover (green manure)	3.8	4.2
9	Corn — oats and sweet clover (green manure)	4.7	5.2

*Nominal soil treatments used. Cornstalks left on plot except when followed by wheat. Soybeans grown in rows the same as corn.

†Measured or calculated losses for the claypan soils (Soil group factor, 1.0).

‡Adjusted losses for Shelby and glacial soils (Soil group factor 1.1).

Per Cent Land Slope Factor, S. The sequence plots at the Missouri Soil Conservation Experiment Farm have a land slope of 3 per cent. When these losses are to be used in calculating the soil loss from a field with a slope other than 3 per cent, a per cent slope adjustment factor must be used. These factors

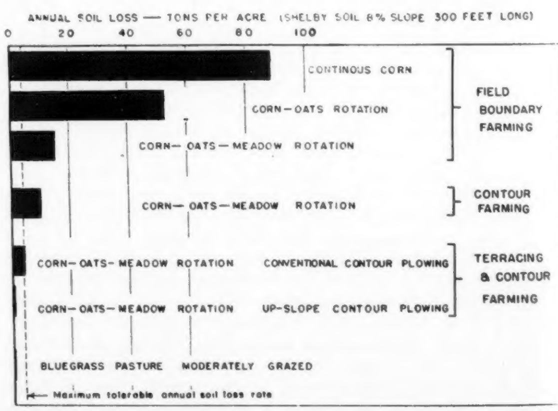


Fig. 1 Terracing, upslope plowing, contour farming and good crop-soil management, all combined, reduce erosion to an inconsequential rate on the Shelby soil of average slopes

This paper was prepared expressly for AGRICULTURAL ENGINEERING, and is a contribution of the Soil Conservation Service (Research), U. S. Department of Agriculture, and the Missouri Agricultural Experiment Station—Missouri College of Agriculture Journal Series No. 1105.

D. D. SMITH and D. M. WHITT are, respectively, project supervisor and soil conservationist, Missouri project, Soil Conservation Service (Research), USDA, and University of Missouri, cooperating. (Agricultural Engineering Building, University of Missouri, Columbia.)

*Superscript numbers refer to appended references.

are shown in Table 2. They were secured by study of data from the Shelby[7], Putnam[3], and Fayette (Cooperative Soil Conservation Research Station, LaCrosse, Wis.) soils. The equation describing the relationship of these factors with per cent slope is not the straight exponential relationship commonly in use. It differs by the addition of a constant which represents the soil loss from a zero per cent slope.

TABLE 2. PER CENT SLOPE SOIL LOSS FACTORS

Per cent slope	Factor	Per cent slope	Factor
1	0.4	8	3.4
2	0.7	9	3.9
3	1.0	10	4.5
4	1.4	11	5.1
5	1.8	12	5.7
6	2.3	15	7.7
7	2.8	20	11.5

Length of Land Slope Factor, L. The experimental plots from which the data of Table 1 were secured are 90 ft in length. In the field, the slope length is several times this length, except when shortened by terracing. Length of slope adjustment factors are shown in Table 3. They are based on research studies on the Shelby soil of Missouri[5,6]. The studies show that for slopes of uniform steepness within the range of the experiments, soil loss per unit area increases on the average as the 0.6 power of the slope length. This relationship appears to hold for most of the other Missouri soils.

TABLE 3. SLOPE LENGTH SOIL LOSS FACTORS

Length, ft	Factor	Length, ft	Factor
72.6	0.9	500	2.8
90	1.0	600	3.1
100	1.1	700	3.4
200	1.6	800	3.7
300	2.1	900	4.0
400	2.5	1000	4.2

If the limits of application of the relationship are not considered in determining the slope length of a field, the use of these slope-length factors will result in erroneous conclusions. Soil loss increases with slope length only so long as the per cent slope increases or remains constant. A decrease in per cent slope generally results in deposition of soil a short distance beyond the point of decrease. The measured slope length for a field should be the shortest distance the runoff travels to reach this point.

Soil Group Factor, K. The claypan soils as represented by plots on Putnam soil at the experiment farm near McCredie appear to erode at somewhat different rates than some of the other soil groups of the state. Unfortunately data for direct comparisons are not available. Soil loss measurements have been made in the corn belt under similar cropping, although the per cent land slope has not been the same. Soil group factors were calculated by making slope adjustments and assuming equal rainfall patterns. They indicate the following for Missouri:

Fig. 2 Upslope plowing of meadow land has proved practical even on this Shelby loam soil field of 20 per cent slope between terraces

River hills (bordering the Missourl and Mississippi Rivers)	1.2
Shelby and associated glacial soils	1.1
Claypans (NE and SW level prairie)	1.0
Marshall and associated loess soils and Ozark region soils	0.9

The values for the Ozark soils are estimates based on observations and consideration of the physical properties of these soils. All of the values are tentative and may be changed by additional experimental data. They are suggested for use in calculating field soil losses until more conclusive data are available.

Contour Farming Factor, P_c. The effect of contour farming on soil loss has been studied on a Shelby soil of 7 per cent slope at Bethany, Mo.[5]. It has also been studied on a 2 per cent slope at Urbana, Ill., and on a 16 per cent slope at LaCrosse, Wis. (Cooperative Soil Conservation Research Stations), both on soils similar to some of the principal Missouri soils. These data indicate that the relative soil loss from contour farming as a decimal of that lost from up-and-down-hill farming is a minimum for slopes of 5 to 7 per cent. For slopes either less or greater than this range it approaches unity. This point probably occurs at a land slope slightly greater than zero and again at a slope of about 25 per cent. These values are shown in Table 4 with interpolated values for the in-between points secured by plotting the available data. In use of the erosion equation to compute soil loss from a contour farmed field, appropriate contour farming practice values must be used. The reason for this is that the experiment farm plots from which the rotation soil losses of Table 1 were secured are operated up and down slope.

Observations of contour farming have shown that excessive breaking over of contour rows occurs on the longer slopes. This has been particularly serious for the more severe rains. Maximum safe slope length limitations for contour farming have been determined from observation and included in Table 4.

TABLE 4. CONTOUR FARMING PRACTICE FACTORS P_c

Land slope, per cent	Practice values (P_c)	Source of data	Maximum safe slope length, ft
Level	1.00	Theoretical	—
1	0.74	Interpolated	500
2	0.60	Urbana, Ill. data*	400
3	0.54	Interpolated	300
4	0.52	Interpolated	300
5	0.50	Interpolated	250
6	0.50	Interpolated	250
7	0.50	Bethany, Mo. data*	200
8	0.52	Interpolated	200
9	0.55	Interpolated	200
10	0.58	Interpolated	200
12	0.64	Interpolated	200
16	0.80	LaCrosse, Wis. data*	200
20	0.90	Interpolated	200
25	1.00	Theoretical†	200

*Cooperative Soil Conservation Research Stations.

†The point at which a 4-5-in furrow between corn rows loses its retention capacity.

Calculation of the field soil loss with contour farming can be simplified by combining the contour factors of Table 4 with the per cent land slope factors of Table 2. This will give a set of per cent slope-contour factors that may be used with the length of slope factors of Table 3 to make two-dimensional tables or graphs for determination of field soil losses.

There are few, if any, farmers who farm directly up and down slope. Most straight-row farmers plant and cultivate with the field boundary most nearly on the contour. Thus the saving in soil indicated for contour farming over direct up-and-down-slope farming is greater than generally occurs in the field when a farmer adopts contouring. Data from a 5-acre watershed with a slope of about 8 per cent at Bethany[5] indicated the practice value for field-boundary farming to be 0.78. This is about halfway between the practice value for contour farming and direct up-and-down-slope farming. Thus

practice values for field-boundary farming may be calculated by use of the contour practice values in Table 4. For an 8 per cent slope it would be (0.52 + 1.00) ½. These calculated values could be used in the erosion equation for calculating field soil loss for field-boundary farming.

Terracing. Estimating soil loss with terracing follows a somewhat different pattern than with field-boundary or contour farming. There is a small increase in per cent of land slope and a large decrease in length of land slope as a result of terrace construction. The slope length is limited to a definite figure for each per cent of land slope. Contour farming is an essential requirement for farming terraced land. By consideration of slope changes and the effect of contour farming, a different set of slope factors can be determined. They are shown in Table 5.

TABLE 5. SLOPE-SOIL LOSS FACTORS FOR TERRACING (S_t)

Per cent slope	Factor	Per cent slope	Factor
1	0.4	8	2.4
2	0.6	9	2.8
3	0.8	10	3.3
4	1.0	11	3.8
5	1.3	12	4.5
6	1.6	15	6.6
7	2.0	20	10.0

The calculated soil movement to the terrace channel is the product of the appropriate factor from Table 5 and the rotation plot loss from Table 1. Not all of this, however, is soil lost from the field. Research studies[5] have shown that soil loss in runoff will be from 5 to 10 per cent of the amount moved to the channel. The remaining 90 to 95 per cent is not lost from a crop-production standpoint if the rate of deposition is not too great. Studies on the Shelby soil at Bethany indicated that an annual rate of 3 tons per acre or less would not be excessive. Assuming the value of 10 per cent for soil loss in runoff from the field and 3 tons as an allowable deposition value, it is possible to set up an erosion equation for terraced land as

$$A_t = \frac{CS_t}{10} + (CS_t - 3)$$

if CS_t is less than 3, the soil loss A_t is limited to $CS_t/10$.

It is possible and practical to move part, and in some cases all, of the soil deposited in the terrace channel back up the slope. By doing this, more intensive cropping systems can be used on the steeper slopes. It is accomplished by upslope plowing, which means turning each furrow slice up hill when plowing, as shown in Fig. 2. The two-way or hillside plows available make this entirely practical and no more difficult than conventional contour plowing except on the extremely steep slopes. The amount of soil moved up the slope by this method of plowing is of rather large proportions. The per-acre rate increases as the land slopes become steeper because of the decrease in horizontal terrace spacing. The rate of upslope soil movement by one normal plowing on terraced land is shown in Table 6.

TABLE 6. UPSLOPE MOVEMENT OF SOIL BY ONE PLOWING (FURROWS 14 IN WIDE AND 7 IN DEEP) ON DIFFERENT LAND SLOPES

Per cent slope	Tons per acre	Per cent slope	Tons per acre
2	13.9	8	22.7
3	16.1	9	23.5
4	17.8	10	24.5
5	19.1	11	25.3
6	20.4	12	26.1
7	21.5	15	26.7

When this method of plowing is used, the erosion equation for terraced land becomes

$$A_t = \frac{CS_t}{10} + (CS_t - 3 - U)$$

where U is the annual rate of upslope soil movement by upslope plowing. To compute U, divide the appropriate figure from Table 6 by the average interval between plowings as required by the cropping system. For example, for a 3 yr rotation, if one plowing is required within the cycle, divide by 3; if two plowings, divide by 1.5. If CS_t is less than $(3 + U)$, the soil loss A_t is limited to $CS_t/10$.

Allowable Soil Loss. The ultimate objective of soil conservation is to maintain soil fertility, and hence crop production, indefinitely. Any soil loss that permits a decline in fertility must therefore be avoided. With organic matter as the criterion of soil fertility, yearly change in organic matter content was plotted against annual soil loss in tons per acre to determine the maximum soil loss rate permissible without a decline in fertility. Data were available to do this for the Shelby, Marshall, and Putnam soils.

On the basis of these data, a loss of 4 tons per acre per year for the Marshall and Shelby soils and of 3 tons per acre for the Putnam soil could be permitted. Annual losses in excess of these amounts were accompanied by a decline in fertility. Conversely, the fertility level was maintained or increased on plots having less than these amounts. Data are not available for other soils of the state, but considering the soil characteristics, it seems safe to suggest a value of 4 tons per acre annually for all except the claypans and the Ozark region soils. For these claypan soils a value of 3 tons would be preferable, and for the Ozark region soils 2 tons. These values are tentative and subject to revision with more data and investigation of other fertility aspects in addition to organic matter.

Application. Selection of a cropping system for use with contour farming can be simplified by the use of tables. They can be prepared by selection of rotations from Table 1 after solution of the erosion equation for C, using the appropriate maximum allowable soil loss rate for A and the factors from Tables 2, 3 and 4 required for the desired combinations of per cent and length of land slope. If the plot soil loss listed in Table 1 for the selected rotation and soil does not exceed the calculated value of C for the field slope per cent and length combination, the field soil loss will be equal to or less than the allowable annual rate.

TABLE 7. PERMISSIBLE GRAIN AND ROW-CROP ROTATIONS FOR USE WITH DIFFERENT CONSERVATION PRACTICES ON SHELBY SOIL NORMALLY CONSIDERED SUITABLE FOR THIS TYPE OF CROPPING

Rotation numbers from Table 1

Land slope, %	Field boundary*,†	Contour farming†	Terraced land: Conventional contour plowing	Terraced land: Upslope contour plowing
3-4	1 to 3	1 to 6	1 to 9	1 to 9
5-6	1 & 2	1 to 3	1 to 7	1 to 9
7-8	1	1 & 2	1 to 6	1 to 9
9-10	—	1	1 to 3	1 to 4, 6 to 9
11-12	—	1	1 & 2	1 to 4, 6 & 7
12-14	—	—	1 & 2	1 to 4

*Farm with field boundary which is nearest to being on the contour.
†All waterways required to be in grass sod. Maximum slope lengths are from Table 4.

The result of the application of this process to contour farming on the Shelby soil is shown in Table 7 under the heading "Contour farming." The rotation numbers in Table 7 refer to the rotations with the corresponding numbers in Table 1. The numbers of the permissible rotations for field boundary farming on the Shelby soil are also shown in Table 7.

Selection of a cropping system that will permit economic maintenance of fertility and prevent excessive channel deposition on terraced land can also be simplified by the use of tables. They can be prepared by selection of rotations from Table 1 after solution of the erosion equation for terraced land for the value of C with A_t equal to the appropriate maximum allowable soil loss rate. Slope factors (S_t) for terraced land are secured from Table 5. Rate of upslope soil movement U is secured by use of (Continued on page 398)

Drying Peanuts with Heated Air

By J. W. Sorenson, Jr.
Member A.S.A.E.

ALTHOUGH peanuts are becoming an increasingly important crop in Texas, much still needs to be done in all phases of production. The industry cannot be expected to expand or even remain on the same status as it is today unless the farmer can grow peanuts more economically and with less risk than in the past few years. This means that the labor involved in growing peanuts must be reduced and the method of handling improved. Complete mechanization appears to be the answer to these problems. The greatest need at the present time is for improved methods of harvesting and drying.

Methods of Harvesting. The first step in the harvesting operation is to plow out or dig the peanuts. This is usually done by placing two long-blade half-sweeps on the cultivator frame of the tractor. One right and one left-hand sweep are mounted so that the wings extend toward each other under the tractor. These sweeps cut the tap root and lift the plants with the nuts attached out of the ground.

The conventional method of threshing the nuts from the vine is by using a stationary thresher. With this method, the next step after "digging" is to get the peanuts in piles. The peanuts are first put in windrows with an ordinary side-delivery rake and then thrown into small piles, usually with a pitchfork, but in some cases with a mechanical piler. Some hand labor is required to smooth and round the piles even when a mechanical piler is used, however. The peanuts must then be left in these piles for a period of ten days to two weeks, depending upon the weather, before being threshed. This method of harvesting has several serious objections. In the first place, a large outlay of equipment and labor are required to operate the thresher. A crew of 12 to 14 men are required to operate the machine efficiently as well as five or six tractors with trailers to haul the crop to the thresher. Piling the peanuts by hand not only requires a large amount of labor, but many times late rains make it necessary to leave the peanuts in the field for weeks before they can be threshed. This not only causes many of the nuts to drop from the stems, but also reduces the grade of the peanuts. The value of the hay is greatly lowered, if not completely lost.

In an attempt to overcome the objections encountered with this method of harvesting, tests in threshing peanuts directly from the windrows were started in 1945 by the Texas Agricultural Experiment Station located at Stephenville. With this method, the peanuts are dug in the usual manner and then windrowed with a side-delivery rake. Usually four to eight rows are thrown into a single row, depending on the yield. The peanuts are not piled as is customary when a stationary thresher is used, but are picked up from the windrow by the combine which threshes the nuts from the vine. It was found that is was not necessary to wait until the vines were dry before threshing, but that an excellent job could be done after the plants had been plowed up only two or three days.

Additional tests in harvesting were made at the Stephenville Station in 1947 by using a forage cutter to remove the vines before the peanuts were dug. This machine clipped the tops off, chopped them into short lengths and then elevated the chopped hay into a trailer. The stubble was then dug in the usual manner, raked and combined the same day. The main advantages to this method of harvesting are that the crop can be harvested with a minimum loss of nuts and the vines can be salvaged without prolonged exposure to the weather. Although some difficulties were encountered in combining the stubble, it is believed that this method has definite possibilities. Further tests are planned for next year with the hope of overcoming some of the objections found last season.

Regardless of the method of harvesting, however, the threshed peanuts are usually too high in moisture to be sold on the market. Before the peanuts can be sold, the moisture must be reduced to approximately 7 per cent; but even with a long period of field curing, as is necessary when the stationary thresher is used, the threshed peanuts usually contain too much moisture to be sold. When the combine is used, the peanuts are still high in moisture when the vines are dry enough to do a good job of threshing. In either case this means that the sacks of threshed peanuts must be stacked in the field and dried for a time before selling or storing. This again subjects the peanuts to the weather with the probability of increasing the concealed damage to the kernels. It is not unusual to stack the sacks in the open for a period of 6 to 8 weeks before they are reduced to the desired 7 per cent moisture.

Artificially Drying Peanuts. Those interested in peanut production agree that developments in harvesting are tied in very closely with developments in drying both the peanuts and the hay. In fact, mechanical methods of harvesting will be somewhat limited until proper curing methods are developed. For this reason, studies were started in 1944 by agricultural engineers of the A. and M. College of Texas to develop simple and inexpensive methods of drying peanuts and peanut hay. During the past three years peanuts have been dried both on the vine and threshed. The threshed nuts have been dried both in sacks and in bulk.

In the fall of 1944, W. M. Frasier, Houston, Texas, used his barn hay drier for drying peanuts on the vine. The peanuts were dug in the usual manner and the vines, with the peanuts attached, were brought to the drier as soon as possible, in some cases before the leaves had completely wilted. The capacity of his drying unit was 22,400 lb, dry basis, and it required 133 hr to dry this amount. Later tests indicated that this time could have been materially shortened by increasing the amount of air forced through the hay. The cost

Upper left: Experimental peanut combine equipped with pickup attachment operating on Texas Agricultural Experiment Station farm at Stephenville, Texas • *Lower left:* Close-up of pickup attachment on experimental combine • *Right:* A barn hay drier being used to dry peanuts in sacks

J. W. SORENSON, JR., is associate agricultural engineer, Texas Agricultural Experiment Station (College Station).

This paper was presented at the meeting of the Southwest Section of the American Society of Agricultural Engineers at Texarkana, Texas, March, 1948.

of fuel and power for drying the hay and nuts was $2.67 per ton, dry basis. It was found that the hay dried faster than the peanuts, and some additional drying of the nuts was needed after they were threshed.

In 1946, A. L. Carter, Hempstead, Texas, used his barn hay drier to dry threshed peanuts in sacks. He dried approximately 1013 tons from an average initial moisture content of 18 per cent to an end moisture of 8 per cent. The sacks were placed on the drier one to three deep, depending on the initial moisture content. It required an average of 12 hr to dry the peanuts when 120 F air temperature was used in the air distribution duct.

Approximately 15 tons of peanuts were dried with a barn hay drier at Grapeland, Texas, in 1947. The sacks were placed on the drier two deep and were dried from an average initial moisture content of 10.0 per cent to an end moisture of 5.0 per cent in approximately 9 hr. The average cost of the natural gas and electricity used was $0.60 per ton, dry basis.

There are at least ten barn hay driers in Texas at the present time that are being used to dry peanuts in sacks. Apparently all of these units are operating satisfactorily and the owners are well pleased with the results. However, one precaution should be taken. There is some danger that the peanuts on the bottom will be dried more than necessary in order to dry those on the top to the desired moisture content. This is especially true when the sacks are three or more deep. If the moisture is reduced below 6 to 7 per cent, the testa, or skin covering, breaks easily in shelling. This results in split and damaged kernels, thus lowering the value of the product. It is believed, however, that with proper operation this can be prevented. With the sacks three or four deep, it is better to use a low air temperature with a high air velocity and thus maintain a more uniform temperature and drying rate from top to bottom.

In October, 1947, tests were started at the Stephenville Substation to determine the effects of temperature on the physical and chemical properties of Spanish peanuts. The column-type drier designed by agricultural engineers of the college was used for the tests.

Five batches of peanuts were dried, each weighing approximately 1900 lb, dry basis. All except the first batch were harvested with a combine in the usual manner. That is, the peanuts were dug on the vine, windrowed and then allowed to dry in the field for two or three days before being combined. The first batch was harvested by clipping the vines with a pickup cutter. The stubble was then plowed out, windrowed, combined, and loaded into the drier the same day.

The initial moisture content of the peanuts ranged from approximately 10 per cent to as high as 27 per cent. The temperature of the air just before it entered the peanuts varied for the different tests, but ranged from an average of 117 to 140 F. Samples were taken before and after drying from each batch. Part of each sample was used for germination tests and the other part sent to the Cottonseed Products Research Laboratory located at College Station for the purpose of making chemical analyses.

In drying batch No. 4, the time required to remove approximately 8.5 per cent moisture was 4¾ hr, while the time required to remove the same amount of water from batch No. 5 was 2¾ hr. One reason for this difference was the higher air velocity used for batch No. 5. However, another reason was that this batch was reduced to 11.3 per cent moisture in 1¼ hr and then left in the drier over the weekend. When the drying started the next Monday morning, the peanuts tested 9.3 per cent, a reduction of 2 per cent without any air being forced through the peanuts. It appears that at the end of the drying, the shell is so much lower in moisture than the nut that some of the moisture is taken up by the dry shell and thus lowers the moisture of the nut. It was found that the same thing happened during storage. To check this two sacks of batch No. 4 were removed from the drier when the peanuts tested 7.80 per cent moisture. After remaining in sacks over the weekend, the peanuts had dropped to 5.73 per cent moisture. This being the case, the drying operation should be stopped when the moisture has been reduced to about 9 per cent. In this way the peanuts will probably not drop below the desired 7 per cent moisture level.

The thickness of the columns used in these tests was 10 in. With this width of column, there was very little variation in temperature from the inside to the outside after a period of 45 to 60 min. It is believed that an 18 to 20-in column could be used for drying peanuts without much variation in temperature. This would greatly increase the capacity of the drier as well as reduce the operating expenses.

Results of the analyses made by the Cottonseed Products Research Laboratory give no indication of immediate serious damage to the peanuts, due to the drying treatments, which would make the peanuts undesirable for crushing purposes. However, the keeping quality of the peanuts cannot be determined until they have been stored for a time. Therefore, the analyses will be repeated after the samples have been stored in the laboratory for a period of about six months.

From the results of the germination tests, it appears that the temperature of the peanuts can be as high as 130 F (drying air temperature of approximately 140 F) without any detrimental effect on germination. More tests need to be made, however, before drawing any definite conclusions. Next year it is planned to make germination tests at intervals through a several-month period to see if any differences develop with age.

From the results obtained during the past few years, it is believed that peanuts can be dried successfully with heated air. However, much information still needs to be known before any definite recommendations can be made. It is our plan to continue the tests already started in both bulk and sack drying. By doing this we hope to be able to develop or improve equipment that will be satisfactory for drying both peanuts and peanut hay.

Evaluating Soil Losses

(Continued from page 396)

Table 6. The rotation numbers listed in Table 7 for terraced Shelby soil were secured in this way.

As the soil group factor for the Shelby soil is 1.1, plot soil loss values from the right-hand column of Table 1 were used in selection of the rotation numbers listed in Table 7. For the claypan soils (Soil factor, 1.0) the plot soil loss values listed in the next column of Table 1 would have been used. For soils with other group factors a different series of plot soil loss would be required. They would be calculated by multiplying the values in the left-hand soil loss column of Table 1 by the appropriate soil group factor.

Use of Table 7 will show the necessity of uphill plowing if the fertility level is to be maintained and excessive channel deposition prevented when grain and row crops are grown on the steeper slopes. The only alternatives to this method of preventing excessive erosion and declining fertility on the steeper slopes would be changing the land use to provide a continuous sod cover of grass and legumes, or the growing of timber.

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The Training of Agricultural Engineers

By Arthur W. Turner

RECOGNIZING that there is a need for increasing food production throughout the world, there must be need also for more agricultural engineers, for they are in reality the engineers of food production. But what background must such an engineer have?

He must be an engineer because he deals with power, labor, methods, and materials. He must also know farming and the problems of crop and livestock production, processing, and marketing. In other words, he must know agricultural fundamentals in addition to having the technical knowledge of the engineer who goes into any other industrial field.

The agricultural engineer needs a knowledge of soil tilth with regard to respective kinds of soils, climate, and crops. One might refer to this as soil physics. What is the nature and frequency of cultivation needed to control weeds and to stimulate maximum production in any given soil and for each particular crop? What are the possibilities of using chemicals, heat, and electric energy in weed treatment in the various field operations? These require a background of agricultural training for their solution.

The agricultural engineer also needs a working knowledge of plant science and a close relationship with the plant breeders. He knows the characteristics he desires in seeds or seed pieces for precision planting, and such characteristics as the type of straw or stalks desirable for harvesting. For harvesting, the ideal situation would be to have a universal machine for all crops. However, this seems impossible because of the wide variety of the present physical characteristics of the various crops. Probably, however, individual machines can be adapted to harvesting a wider variety of crops than is now done.

Thousands of varieties of insects attack our crops and animals. The entomologists develop insecticides and fungicides, both liquid and dust, but they and equipment manufacturers have been handicapped by lack of satisfactory methods and equipment for application, whether by ground or airplane application.

How and where should the agricultural engineer be trained? Here I am giving my personal views, based on observation of engineers in all branches of agriculture. The logical place for training is the land-grant college offering both engineering and agricultural training. The agricultural engineer needs a strong agricultural engineering consciousness that will enable him to understand and apply engineering principles to agriculture in both a scientific and practical manner. Every state can and, I believe, should have at least one strong agricultural engineering department.

I do not fully subscribe to four years of engineering training and one year of agriculture, or four years of agriculture and one or more years of engineering. Neither procedure develops a proper agricultural engineering consciousness. Institutions having a four-year curriculum in engineering should have a four-year curriculum in agricultural engineering.

The administration of agricultural engineering training, to my thinking, should be a joint responsibility between the dean of engineering and the dean of agriculture. The engineering requirements of agriculture are a combination of engineering fundamentals and agricultural fundamentals. They are not the so-called trades or skills but the basic fundamental requirements of the two professions. One without the other is apt to result in lopsided training and subsequently lopsided viewpoints.

It will not be sufficient in developing the professional agricultural engineering curriculum to reshuffle the present engineering and agricultural courses and expect the agricultural engineering student to sift out the wheat from the chaff. One of the handicaps in agricultural engineering training today is insufficient text materials and teaching examples of engineering applications to agriculture. It is essential to study not only the over-all curriculum, but also to organize some special agricultural engineering technical courses. This applies to both engineering and agriculture. Take the applied mechanics of field machines for example. Agricultural equipment does not have the solid foundation of the power-generating plant, the steel rails of trains, or the concrete roads necessary for operation of motor vehicles. Instead, farm machines operate over uneven terrain. Power is transmitted at angles by sprocket, shaft, belt, and chain, and through the power take-off, and the angles change in both horizontal and vertical planes while the machine is in operation, either to meet terrain irregularities or crop requirements.

Another example includes farm buildings which represent a large part of the farmer's investment and affect his income in several ways. Where climatic conditions are unfavorable, the amount of milk or eggs that a farm produces is likely to depend on the capacity or the convenience of the buildings. Storing the various crops is dependent on the conditioning requirements of each crop—how moisture is transferred from the center of a kernel or seed to the surface where it can be evaporated or removed. Controlling or eliminating moisture migration in grain storages is another essential in grain storage design.

Specialized courses in engineering, and especially in agriculture, could concentrate much essential material into fewer and more useful courses. For example, take the material on soil physics already mentioned. One good course in soil physics could cover soils for the agricultural engineer, if presented as related to the structure of soils, characteristics which affect tillage, traction, erosion, and similar factors. Livestock should be studied from the standpoint of housing and care instead of merely judging individual animals. Field crops should be studied from the mechanical standpoint for production and the agronomic standpoint for storage and utilization.

Another course which I believe should be in every engineering curriculum has to do with the engineer's responsibility for developing and understanding the economic and social phases of his work. One of the greatest dangers to our constitutional form of government and our free economy is the lack of appreciation of how these two great institutions serve everyone and have provided us with the highest standard of living ever achieved. Again and again in meetings and papers of our engineering societies it has been emphasized that the people responsible for high standards must also assume responsibility for translating and publicizing just how our system operates. Our responsibility as engineers is to correct misunderstandings about our economic system, and thus to stop the dangerous undermining which has been going on in some quarters.

Agricultural engineering has the same relationship to agriculture as mining engineering to mining and aeronautical engineering to aeronautics. It is a branch of the engineering profession serving the agricultural industry. That industry, in many of its phases, calls for the highest type of engineering, a far cry from its beginning as "farm mechanics". Its true importance stands out in bold relief.

How can our training of agricultural engineers and the applications of engineering in agriculture be strengthened. Increasing numbers of young men feel a responsibility in applying engineering to agriculture. Many agricultural engineers are already doing yeoman service. Both deserve the benefits of state licensing now provided other engineers. We request your continued cooperation in seeing that this is realized in every state.

The world's increasing need for food has emphasized the need for better trained agricultural engineers—that more food can be produced for all peoples—thus removing an important age-long disturber of world peace.

Excerpt of a paper presented before the Engineering Education Section, Association of Land Grant Colleges and Universities, at Washington, D. C., November, 1947.

ARTHUR W. TURNER is assistant chief, Bureau of Plant Industry, Soils, and Agricultural Engineering, U. S. Department of Agriculture, in charge of agricultural engineering research.

RESEARCH NOTES

A.S.A.E. members and friends are invited to supply, for publication under this heading, brief news notes and reports on research activities of special agricultural engineering interest whether of federal or state agencies or of manufacturing and service organizations. This may include announcements of new projects, concise progress reports giving new and timely data, etc. Address: Editor, AGRICULTURAL ENGINEERING, St. Joseph, Mich.

USDA Notes on Alaska Potato Storage, Farmhouse Plans, Rice Drying, Corn Drying, Corn Cob Concrete, Light-Trapping Moths, and Research Appointments

ALFRED D. EDGAR, agricultural engineer with the Division of Farm Buildings and Rural Housing, USDA, and Don Irwin, director of the Alaska Agricultural Experiment Station, have collaborated on an attractive publication called "Potato Storage in Alaska's Matanuska Valley." It has recently been issued as Alaska Agricultural Experiment Station Circular No. 7.

The 24 illustrations show the principal types of storages used in the Matanuska Valley, with their good and bad features. Valley farmers can produce enough potatoes for the Anchorage area if the crop can be kept satisfactorily from one year to the next, but the Alaska climate demands better-than-average storage and management and present facilities are inadequate. Research is being carried on at the Matanuska station with the object of lengthening the safe storage period and improving the quality of the stored potatoes.

More Farmhouse Plans. Extension agricultural engineers, home demonstration leaders, and home management specialists have just received copies of Information Series No. 90, More New Farmhouse Plans, announcing the availability of the remaining house plans to be included in the revised Northeastern Plan Exchange Service. The first six of the plans for this region were announced some time ago in Information Series No. 80. These and the new nine were developed cooperatively by the state colleges and extension services of the northeastern region and the USDA.

Information Series No. 90 is issued for administrative use only so that states wishing to include the plans in their plan exchange services may place advance orders for brown line prints. A catalog illustrating and describing all of the farmhouse plans for the Northeast is now being prepared for distribution to all state and county extension offices.

The new plans include a minimum house with a gable roof trussed to eliminate bearing partitions, a one-story two-bedroom house to which two more bedrooms can be added, story-and-a-half houses of popular types, and large houses incorporating many features for comfortable farm family living. Most of the plans are adapted to either frame or masonry construction.

Rice Drying. When the cooperative Research and Marketing Act project to improve methods, structures, and equipment for the drying and storage of rice was established, an immediate objective was publication of a mimeographed circular incorporating a review and analysis of existing literature on rice drying and storage for use by rice growers and drier operators and as a guide in planning research. Preparation of the preliminary draft of this publication was undertaken by Harold A. Kramer, agricultural engineer, Division of Farm Buildings and Rural Housing, in charge of the project with headquarters at Beaumont, Texas. Review by cooperating agencies followed, and the circular should be available this month.

In question and answer form, the information presented covers the subjects of combining rice for drying, operation of rice driers, handling partly dried rice, changes in quality after drying, loss of weight in drying, moisture tests, drying rice for seed, technical points on drying, and safety and dust control. The attempt has been to assemble from scattered sources the best authoritative advice available for use in handling this year's crop. A bibliography on rice drying concludes the publication.

Corn Drying on the Stalk. RESEARCH NOTES for August, 1947, reviewed a report by J. L. Schmidt on a study of the effect of freezing on the drying rate of ear corn on the stalk. The investigations were made at Ames in the early fall of 1946. Mr. Schmidt now reports results of follow-up studies done in October, 1947. The experiment of subjecting a row of corn to artificially induced frost was repeated. Stripping leaves and exposing broken ears were not repeated, but a new treatment was introduced which consisted of spraying with Stoddard's Formula, a naptha adapted for weed killing.

The freezing treatment in 1947 gave about the same results as in 1946, the effect differing only as to its reaction time and its severity. In both studies freezing the corn hastened the drying as compared to unfrozen corn, but reduced yield and quality to some extent. Spraying the corn plant with Stoddard's Formula also hastened the drying rate. Two weeks after treatment the difference between sprayed and unsprayed (approximately 5 per cent) was greater than between frozen and unfrozen corn. Growth of the sprayed corn did not entirely stop but was hindered. Controlling the rate of application of the spray would make possible control of the degree of killing.

Corn Cob Concrete. From East Lansing, Mich., come promising preliminary test results on concretes of various mixtures using corncob pellets as fillers. J. S. Boyd, assistant professor of agricultural engineering at Michigan State College, and USDA engineer Gerald O. Edgerly of the Division of Farm Buildings and Rural Housing are making the pilot tests under a cooperative Research and Marketing Act project. Edward G. Molander is in charge for BPISAE of this and other functional requirements projects.

Hundreds of thousands of tons of corncobs pile up annually on farms and at country elevators. Research workers hope to develop techniques and mixes for using some of these waste cobs in farm concrete construction. Lowered building costs and a concrete of higher insulating value are anticipated from material which now creates a disposal problem.

Results of compression and flexure tests on the experimental mixes are encouraging. Indications are that larger corncob pellets, or graduated mixtures of small and large, work better than small pellets. Edgerly and Boyd have prepared the cobs by running them through a hammer mill. They are working with sizes from 1/4 to 1 in in diameter and with mixes using various combinations of sand and stone aggregates.

Specimens for the compression and freezing and thawing tests are cylindrical, and those for flexure tests are beam type. Cubes will be molded for absorption and hollow cubes for heat insulating value tests. Field tests will include samples exposed to weathering and larger sections built up and subjected to wind and service loading.

Light-Trapping Corn Borer Moths. At the Purdue Agricultural Experiment Station, John G. Taylor, USDA engineer in charge of the light trap project, is catching gravid female European corn borer moths of this season's second brood, after a heavy first brood. His field studies last year and laboratory studies this February and March indicate rather definitely that the moths are attracted most strongly to radiation in the near-ultraviolet or "black light" band. Two lamps with this type of radiation caught more moths than the total catch of two each of white, blue, green, and bactericidal lamps. This season, consequently, he is concentrating on determining the most effective intensity of radiation. Preliminary results indicate that the greater the intensity the greater the attraction. The two high-intensity light traps caught more moths than the other six lamps tested.

The USDA Division of Farm Electrification is receiving active cooperation in this work from the engineering department of the General Electric Company's lamp works in Cleveland. An interesting sidelight is the fact that insecticide manufacturers are recommending field installations of light traps as a guide to timing spray applications.

Research Appointments. Recent graduates of college agricultural engineering departments across the country are among new appointees to research posts at various USDA project headquarters, as follows:

Kenneth O. Smith, B. S. in agricultural engineering, University of California, is agent (junior agricultural engineer) on the cotton mechanization project at Fresno, Calif.

Theodore E. Bond, B. S. in agricultural engineering, University of California, is agent (junior agricultural engineer) on the swine environmental studies at Davis, Calif.

John G. Herndon, B. S. in agricultural engineering, University of Georgia, is junior agricultural engineer on the sugarcane mechanization project at Houma, La.

Day L. Bassett, B. S. in agricultural engineering, Utah State Ag. College, is junior agricultural engineer on the dairy barn project at Logan, Utah.

Thomas E. Wright, B. S. in chemical engineering, University of Tennessee, is associate mechanical engineer on cotton ginning investigations, Stoneville, Miss.

Rex F. Colwick, B. S. and M. S. in agricultural engineering, Texas A. & M. College, is agent (associate agricultural engineer) on cotton mechanization at Lubbock, Texas.

Russell E. Larson, B. S. in agricultural engineering, University of Minnesota, is agent (junior agricultural engineer) on the weed control project at St. Paul.

Elmo S. Renoll, B. S. in agricultural engineering, Alabama Polytechnic Institute, is part-time agent (junior agricultural engineer) on the weed control project at Ames, Iowa. He is a graduate student in agricultural engineering at Iowa State College and was previously a part-time employee of the Farm Machinery Division at Auburn, Ala.

Charlie M. Stokes, B. S. and M. S. in agricultural engineering, Alabama Polytechnic Institute, is agent (associate agricultural engineer) on the cotton mechanization project at Auburn. Since his discharge from service he has been on the staff of Alabama Polytechnic Institute.

William A. Balk, B. S. in agricultural engineering, University of Georgia, is agent (junior agricultural engineer) on cotton mechani-

zation at the Sand Hill Experiment Station, Columbia, S. C.

Joseph K. Jones, B. S. in agricultural engineering, Mississippi State College, is assistant agricultural engineer on cotton mechanization at Stoneville, Miss.

George B. Duke, B. S. in agricultural engineering, University of Georgia, is agricultural engineer on sugar cane mechanization at Houma, La. For the past two years he has been professor of agricultural engineering at Abraham Baldwin College, Tifton, Ga. Previously he was an engineer with Deere and Co.

Gerald O. Edgerly, B. S. in agricultural engineering, Michigan State College, is agent (junior agricultural engineer) on the structures materials project at East Lansing.

Carl W. Brockseker, chief engineering aide, has been transferred from special fibers investigations at Boynton, Fla., to the rural industries project at Athens, Ga.

Charles C. Speakes, B. S. in mechanical engineering, Georgia School of Technology, is assistant mechanical engineer on cotton ginning investigations at Stoneville, Miss. He was formerly with Curtiss-Wright at Columbus, Ohio.

Hawaii Notes on Napier Grass Harvesting, Fence Post Preservation, and Irrigation

By J. F. Cykler

MECHANIZATION applied to the harvesting of forage crops in the dairy industry is a growing need. Experiments on present-day corn ensilage harvesters have shown that with proper modification they will operate satisfactorily in Napier grass. Normally these machines are pulled behind a tractor and have auxiliary power. The harvester cuts the grass within 6 in of the ground using a single corn sickle section. Gathering and elevating chains elevate this cut material and deliver the stalks to the feed rollers and chopper unit. The chopped feed is delivered to a trailer through a blower or a paddle-type elevator.

Corn ensilage harvesters do not have sufficient capacity when operating in Napier grass at the same field speeds that are used with corn. These machines do not operate properly at ground speed below 3 mph. This is due to the improper relationship between ground and elevating chain speeds. At field travel under 3 mph, the grass stalk butts are not delivered to the chopper at the correct angle and bunch in the throat of the unit. There is some inherent difference between corn and Napier stalks that causes this particular difficulty. High field speeds will rectify this problem, but Napier is grown under conditions where high speeds can not be sustained. Normally at high field speeds the harvester, even though it will operate properly with a light cut, will not have the capacity at a full cut. Therefore, the ground speed of the machine must be reduced in order to have sufficient capacity to operate in small, rough fields. At the same time the gatherer and elevating chains must also be slowed, by an amount depending upon the make of harvester and advisable field speed.

A third difficulty is encountered by the outboard wheel. This wheel is so placed that it runs over uncut material. The harvester is not able to pick up this flat grass on the next round, and the field is left in a very ragged condition. For machine A (see accompanying illustration) a small two-wheel truck was fabricated and placed inboard of the regular wheel, and the regular left wheel was removed. To overcome the same difficulty with machine B a set of three 16-in general wheel assemblies were mounted and secured to the main axle of the harvester and the regular right wheel removed.

Existing harvesting methods vary somewhat, depending upon the use of a mower for cutting and the use of a portable ensilage cutter. Some dairies cut by hand and haul the whole stalks to the barn for chopping, while other dairies use a tractor mower but chop the grass in the field and haul the chopped feed to the feed racks. Labor requirements under existing field practices to cut and deliver this chopped material to the feed racks will vary from 2.75 to 9 man-hours per ton. Labor requirements for harvester A under extensive field tests and at a 50 per cent field efficiency was 0.58 man-hours per ton. It is anticipated that harvester B, now undergoing field tests, will further reduce this labor requirement. Preliminary tests indicate a harvesting rate of 475 lb per min.

Fence Post Preservation. In order to help rectify the loss of fence posts through decay on the farms and ranches in Hawaii, a series of fence-post preservative trials have been planned.

An initial study has been set up to include three outdoor plots on Maui, using blue gum eucalyptus. The treatments to be used are as follows: (a) Check plot, 25 posts per area; (b) creosote (American Wood Preservers' Assn. grade 1) — hot and cold bath, 25 posts per area; (c) creosote and diesel oil, 50 per cent and 50 per cent—soaking 96 hr, 25 posts per area; (d) creosote and diesel oil, 50 per cent and 50 per cent—soaking 168 hr, 25 posts per area; (e) 5 per cent pentachlorophenol in diesel oil—soaking 96 hr, 25 posts per area; (f) 5 per cent pentachlorophenol in diesel oil—soaking 168 hr, 25 posts per area.

Irrigation. Work on an underground concrete pipe irrigation water distribution system has been completed. This project was set up to install and develop for Hawaiian conditions the orchard-type underground concrete pipe distribution system now in use in certain mainland areas. Included in the system is a more recent development to control the flow of water in sections of the pipe line through the use of a series of low-pressure float actuated valves. These valves are inserted in the pipe line at approximately every 10-to-12 ft difference in elevation. The valve maintains a low constant pressure in the line irrespective of the demand for water.

One of the difficulties in irrigation layouts is the open concrete flume or open ditch, which prevents efficient mechanical cultivation, wastes water, and presents the problem of high soil erosion. An underground pipe wastes no water, and leaves the ground surface free for mechanical soil operations.

This experimental distribution system has been installed, starting first at the low elevation point using an elbow and 8-in riser, then four 6-in sections of bell-and-spigot 8-in pipe, etc. The tee section supports an 8-in riser capped and closed by an alfalfa valve. Eighteen-inch concrete distribution pots (see accompanying picture) were placed concentric with the riser pipe and set in concrete at the ground level. The distribution pots contain $1\frac{1}{2}$-in galvanized distribution gates which distribute the water from the pipe line to the furrows, either directly or through lightweight pipe. However, the problem of water distribution from the riser pots to the furrow is the point in this system where further development is needed to efficiently adapt this method of distribution to Hawaiian conditions. Design of equipment to meet this need is under consideration.

This system now controls the distribution of irrigation water on a small macadamia nut orchard at the Poamoho substation. From all observations it operates well under orchard conditions.

Toward Easier Feeding

TO THE EDITOR:

MORE information is needed on arrangements for feeding livestock. Since I have been in professional agricultural engineering work, a good many farmers have asked for help in planning feeding arrangements for their farms.

Chopped hay presents a different feeding problem, and I have about concluded that narrower barns are better than wide barns. As yet we just don't have much information on an easy way to feed chopped hay.

Also, there is the problem of getting chopped hay from the field to the barn loft. All blowers give trouble when blowing chopped hay at 35 per cent moisture into the barn.

JESSE B. BROOKS

Lexington, Ky.

An adaptation of a corn ensilage harvester for harvesting Napier grass in Hawaii

Picture shows valve control towers and distribution pots of an underground irrigation distribution system developed for Hawaiian conditions

A Problem for Ag Engineers in Rural Fire Prevention and Control

TO THE EDITOR:

ONE of the activities of the Maine Agricultural Extension Service this past year has been that of sponsoring a series of county meetings on farm fire prevention and control in collaboration with the state forestry department and selected fire chiefs. Eighteen meetings were held with a total attendance of over 1,000 people. Those attending included fire chiefs, forest fire wardens, selectmen, and farm leaders from each community.

The purpose of these meetings was to arouse interest in rural fire prevention and to suggest control measures for rural fires. These county meetings were responsible for holding many community meetings which resulted in the purchase or construction of efficient fire appartus on the part of many of the communities. Cleanup campaigns were also quite common.

One of the questions brought up at these meetings presents quite a problem. There is little a farmer or a farm community can do by the purchase of proper fire-fighting equipment, etc., to lower the cost of fire insurance. Off course, the goal in any effort to prevent and control fires should be to lower losses, which will eventually result in lower costs. Tank-type fire trucks and farm ponds plus an efficient rural fire department (probably volunteer) have been very efficient in the control of farm fires. Yet the people protected by such a setup enjoy little, if any, difference in insurance costs over their unprotected neighbors.

I brought this to the attention of our New England Fire Insurance Rating Bureau which sets the rates for much of New England. The only satisfaction I got was that the rules had been set up 20 years ago and that no community which did not come up to their requirements could get any benefit. These rules, in the main, are set up to require a 500 gpm pumper, a hydrant under pressure within 1,000 ft, and a fire department within 2 or 3 miles. Inasmuch as pressure hydrants are practically non-existent in rural areas, the tank type plus a good network of water hose has seemed the best answer; yet these are not considered in any rate improvement.

It would seem to me that this might be a rather general problem, and one on which ASAE members might get together. The rating bureau admits the value of the equipment (tank trucks, etc.) yet it is not inclined to change the rules. I would be interested in learning if other states or sections of the country have this problem, and I would be glad to assist in any way toward its solution.

E. W. FOSS

Extension agricultural engineer,
College of Agriculture, University of Maine

TO THE EDITOR:

I WAS interested in the problem presented by Mr. Foss in the foregoing letter. What he says is true, in that we have a peculiar and difficult problem in connection with the proper selection of rural fire-fighting equipment, already hampered by insurance rate regulations, and also in getting proper recognition in so far as insurance rates are concerned. Others take advantage of the outmoded insurance rate situation by forcing the purchase of a 500-gal pumper of no value whatever if a water supply is not available in sufficient quantities for this type of fire fighting (and it generally isn't); and if it is, the fire loss could be small but with tremendously out-of-proportion water loss.

With high pressure, both fire and water losses are at a minimum, and the same holds true and even better on upward on the larger fires on a basis of one of our trucks to one of the others.

Assuming that the fire department is interested in the best protection available, we have been able to help in many cases by suggesting that a potential buyer ask the insurance rating bureau in his state as to what credit he will receive if he buys a 500-gal pumper, and what credit he would get if he bought one of our high-pressure units. In many states the credit is the same, or no credit is given in either case, or in many cases, with a pumper, limited to a small area and the major portion of the district getting no credit at all. Such being the case, fire loss reductions and saving of lives should be overwhelmingly the main issue instead of the saving of a few dollars of insurance for a few people in a restricted area.

The fact that high pressure, as we have developed it, fails to get the approval that it deserves is preventing it from going into service in many communities and is costing the insurance companies and property owners unnecessary millions yearly to say nothing of the lives lost, on which so much emphasis is being placed by authorities. This loss can be reduced greatly if proper recognition is granted.

Many local purchasing authorities wish to recognize the value of high pressure from the success of the nearby outfits but their hands are tied by rate restriction. Many have taken the bull by the horns and said, "we want to put fires out regardless of rates."

Still others have purchased the rate-getting equipment to get the rates, and have then bought our unit to put the fires out, and don't hesitate to say so.

The big proof, however, is the department having other types as well as ours and their findings will prove that high pressure is all that is claimed for it and more, and they are in position to make a fair and practical comparison.

Perhaps the National Board of Fire Underwriters has not made a thorough investigation of this matter or has been unintentionally influenced by misinformation not backed up by actual field experinece. We may be accused of being biased, but we know from experience we have had with hundreds of our high-pressure units in operation, just what can be done with them. Time and again they have pulled up behind a pumper, or two or more pumpers with our equipment, either in a rural area or where there are fire hydrants, and have put out fires that would have burned down without high pressure.

Our unit is suitable for all types of fires; it puts the fire out faster with less fire loss, and it uses less water, which means little or no water damage. This speed often saves lives and it is the only answer when little or no additional water is available beyond that carried on the truck.

Fire prevention is necessary, but when it fails you need the best possible equipment to fight the fire. For years, one system only has been advocated on sizeable fires by the authorities, and all this time losses have steadily increased. The system is failing unquestionably and a strong effort should be made to better it.

The general setup which governs insurance rate fixing is one that has been in existance for many years and the NBFU board apparently still feels that it is adequate. Is it from lack of evidence or simply that they are not interested in small fires? By a small fire we mean anything up to a three-story building. Of course, if a small fire becomes a conflagration, then a total loss is generally the result, and many times could be prevented if properly fought at the start.

We believe that any change in the insurance rates, or approval in so far as our equipment is concerned, will be brought about by outside pressure resulting from greatly reduced losses and saving of lives from the use of 850-lb high-pressure fog fire fighters and taking the water required right to the fire. High pressure gives at least a ten-to-one ratio advantage in water over other methods.

In some states they look at it from the standpoint of the merits of each individual case, and have been known to make exceptions on that basis, perhaps because the results from other nearby high-pressure units have made an impression on some of those officials who are really interested in better fire protection and who desire to encourage its advancement because it is so sorely needed everywhere. Many state authorities are heartily in accord with the high efficiency of high pressure, but their hands are tied by higher-ups. They, too, should be consulted.

In support of a better understanding of the demand of high-pressure fire departments for better rate consideration because they use high pressure, we mention that in one county using seven high-pressure units, the total losses by number were reduced to under 10 per cent. In one state not using high-pressure units (if the figures given us are correct), the total loss figure was between 50 and 75 per cent. Of course, both of these total loss figures include buildings that were burned down before the fire department arrived.

Many fire districts whose fire boards want high pressure for better protection, are held back by insurance rates, a fact that seems to be of great importance to mutual insurance companies, with a consequent recommendation for high pressure anyway.

A mutual insurance company in Iowa, The Farmers Mutual Insurance Association of Washington, Iowa, who furnish a fire truck to help protect their policyholders and who had the choice of any fire truck they wanted, purchased one of our high-pressure units.

It is my feeling that whereas the NBFU may have been waiting for greater field experience from high-pressure units, they have not given the matter the complete investigation that it deserves and that it is now ready for them and waiting, or that they have been thrown off the track by poor results obtained from some of the so-called high-pressure units operating at lower pressure that cannot meet our claims.

Surely the NBFU, carrying the responsibility that it does and having charge, you might say, of protecting their sponsors, the insurance companies, will eventually attempt to live up to this responsibility without too much delay.

High pressure can keep little fires from becoming big ones and help to reduce the ever mounting fire loss in this country, and by at least taking a good look at the actual results obtained they can further help the cause. To do less than that is certainly not in keeping with the aims of their sponsors as we feel they want them carried out.

High pressure not only equals; it surpasses. It is often denied consideration for rate reduction incident to its use, and yet other methods are granted it under the same conditions. However, on the basis of efficiency it should be exactly the other way around, with high pressure getting the credit if any distinction is to be made at all.

R. G. PULVER

Fire equipment department,
John Bean Manufacturing Co.

Professional Registration of Agricultural Engineers

YOUR committee has conducted a survey of the current status of registration among ASAE members. Data were obtained by the addition of a special question on the postal cards sent to all members for directory corrections.

Returns indicated that 10.4 per cent of the members are registered as professional engineers. Of the total membership, 3.2 per cent are registered as agricultural engineers, 3.0 per cent as civil engineers, 1.5 per cent as mechanical engineers, 1.1 per cent as electrical engineers, 1.1 per cent as professional engineers, and 2.0 per cent in other branches, including structural, chemical, irrigation, and hydraulic engineering.

A breakdown by states showed Ohio leading with 25 members registered, with nine of them in the agricultural engineering classification. Illinois also had 25 members registered, five of them as agricultural engineers. Total ASAE members registered and the number classed as agricultural engineers in some other states are: Iowa, 15 and 7; Texas, 13 and 7; California, 15 and 1; Nebraska, 10 and 5; Pennsylvania, 10 and 1; Georgia, 9 and 5.

One or more ASAE members are registered as engineers in 35 states, the District of Columbia, Canada, and Mexico. One or more of those in 20 states, the District of Columbia, and Canada are registered as agricultural engineers.

Two or more registration classifications are shown for 28 members. Agricultural engineering appears in twelve of these multiple classifications, combined with civil engineering in 5 cases, electrical 2, professional 2, and one each of structural, consulting architectural, industrial, and chemical engineering, and one with land surveyor.

The total of 217 members registered, including mulitple classifications, showed representation in branches as follows: agricultural engineering 68, civil 64, mechanical 32, professional 24, electrical 23, architectural 8, land surveyor 8, structural 7, chemical 4, irrigation 3, drainage 3, hydraulic 2, industrial 1, municipal 1, sanitary 1, farm management 1, metallurgical 1, sewage disposal 1, and consulting 1.

The National Conference of State Boards of Engineering Examiners has indicated a belief that 80 per cent of the engineers in this country should be registered.

The Committee is preparing additional material on the basis and history of registration, its importance to engineering in general, its importance to the individual, the present trend in registration and its significance, and the importance of registration to agricultural engineering as a branch of the engineering profession and to individual ASAE members.

Contacts with the state boards of engineering examiners have indicated three main reasons for agricultural engineering not yet being included in the engineering classifications recognized by some of the state boards. Some say that to date they have never received any request for registration as an agricultural engineer. Other boards frankly do not recognize agricultural engineering as a distinct branch of engineering. Still other boards have concluded that agricultural engineering is not yet on a high enough plane to be classed as "professional" engineering.

Necessary steps to correct the first situation are obvious. Applications from some engineers already registered in other branches, already registered as agricultural engineers in other states, or otherwise well-qualified for registration in one or more branches, would bring the question up for consideration by those state boards on a favorable basis.

Increased contact between qualified agricultural engineers and the state boards concerned should help to overcome the second reason.

As to the third factor, state boards rely heavily on accrediting of engineering curriculums by the Engineers' Council for Professional Development, as a guide to branches of engineering to be recognized. An increase in the number of institutions in which agricultural engineering is accredited would improve the position of agricultural engineering for consideration by the examining boards.

On this point an engineering dean who has been actively associated with the accrediting activity from its inception has indicated that, from the viewpoint of the accrediting committee, agricultural engineering curriculums have commonly been deficient in engineering training. He indicates that basic elements include a strong foundation in drafting, mathematics, physics, etc., during the first two years; and volunteers the information that most of the agricultural engineering curriculums examined have met requirements in this respect.

He points out that the accrediting committee standard for the third and later years of engineering training includes a minimum of one-third of strictly quantitative matter, requiring applications of the basic physical sciences; and that few agricultural engineering curriculums have met this standard, as evidenced in part, for example, by quiz questions requiring the student to "describe", "discuss", or define", rather than to "compute" or "determine".

Report for 1947-48 of the Committee on Professional Registration of the American Society of Agricultural Engineers — S. M. Henderson (chairman), R. K. Frevert. Adapted from official report.

EDITOR'S NOTE: The seemingly small percentage of ASAE members registered as professional engineers may be accounted for, without apology, by several factors in addition to the newness of strong emphasis on registration, the small number of currently accredited curriculums in agricultural engineering, and the lack of an agricultural engineering classification in the branches recognized by several boards. These factors are as follows:

1 Approximately 20 per cent of the total membership are Junior Members, most of whom are still in the process of professional development toward qualification for registration.

2 More than 18 per cent of the total membership are Associates, who make no claim to being technically qualified for registration, and who are not doing work which should be done or supervised by an experienced engineer. They are interested in the results rather than the methods of agricultural engineering, and in the influence of those results on non-engineering operations.

3 Some 3 per cent are so far advanced in professional development and of such established reputation and position that their registration would be primarily a matter of form of little direct value either to them or to persons employing their services. Some are in higher executive positions in which they are in fact employers of engineers.

4 Many members have established their status in the engineering profession by the alternative method of obtaining a rating in the federal Civil Service, which has long recognized the professional status of agricultural engineers.

5 Many members eligible for registration have had limited incentive to apply for it because they are employed in industry or in federal activities not yet directly influenced by state registration requirements.

Crop Conditioning Equipment

THE Committee on Crop Conditioning Equipment of the American Society of Agricultural Engineers was established in October, 1947, to determine what might be done by the Society, in connection with the development of farm crop drying equipment, to meet certain performance and safety standards based on the best information available. This activity is considered desirable in view of (1) the widely different types of equipment being furnished by manufacturers, (2) the wide range of drying conditions (temperature and delivery of air) supplied by present driers, and (3) the lack of a basis for rating the capacity of the driers. The Society is a logical organization to render a service in this important development by coordinating and making available pertinent information relating to drying and crop driers. For example, the manufacturer is interested in knowing the design and service requirements for drying the various crops on the farm. On the other hand, the farmer is interested in the performance of the drying equipment, and whether it meets the requirements for drying a crop. He is also interested in the safety and control features of a drier.

Prior to the appointment of the Committee, its members participated in formulating the recommendations for the drying of soft corn at the July 21, 1947, conference held in Chicago. In addition, they had an important part in setting up the design and service requirements for different types of corn driers which were used in the purchase of several units by the U. S. Department of Agriculture. Field observations were made on these units during the past storage season.

With these recommendations and requirements as a background, the Committee considered the possibility of circularizing drier manufacturers with a view of having them certify the heat and air capacity of their driers determined by actual tests. Information on safety and control devices was also to be supplied. It was planned to publish through the Society a compilation of the pertinent data which was to include a rated capacity of each of the driers.

At a crop conditioning equipment conference held at Washington, D. C., in May, 1948, the Committee met with a representative of the National Fire Protection Association. It was proposed that the Society be more adequately represented on the NFPA committee on driers and dehydrators. Your present committee should be of considerable assistance to this NFPA committee and the Underwriters Laboratories, Inc., in evaluating the hazards and safety of crop driers particularly as applied to their use on farms.

In view of the foregoing, it is proposed that the Committee's future activities include the following:

1 Formulate a test procedure for evaluating the air and heat delivery of farm crop driers.

2 Establish a uniform basis for rating the capacity of driers in the drying of each of the various crops.

3 Set up in so far as possible the drying conditions (temperature and flow of air) for drying each of the farm crops.

4 Assist and advise with the Underwriters Laboratories and the NFPA committee on driers and dehydrators in formulating recommendations of safety and control features of farm driers.

A report (1947-48) of the Committee on Crop-Conditioning Equipment of the American Society of Agricultural Engineers — H. J. Barre (chairman), T. E. Hienton, W. V. Hukill, and D. G. Womeldorff.

NEWS SECTION

A.S.A.E. Meetings Calendar

October 4 — CHICAGO SECTION (Dinner Meeting), Builders Club, Chicago

October 21 and 22 — PACIFIC NORTHWEST SECTION, Columbia Gorge Hotel, Hood River, Ore.

December 13-15 — WINTER MEETING, Stevens Hotel, Chicago.

June 20 to 23 — ANNUAL MEETING, Michigan State College, East Lansing, Mich.

New Officers of ASEE A-E Division

ANNOUNCEMENT is made of the election of H. J. Barre, head, agricultural engineering department, Purdue University, as chairman of the Agricultural Engineering Division of the American Society for Engineering Education for the ensuing year. Other officers elected include H. B. Walker, professor of agricultural engineering, University of California as vice-chairman of the Division, and A. W. Farrall, head, agricultural engineering department, Michigan State College, as secretary.

Dr. Barre was also elected to serve a two-year term on the Council of ASEE, representing the Agricultural Engineering Division.

Mack Jones New A-E Head at Missouri

ACCORDING to word received from J. C. Wooley, he has resigned as head of the agricultural engineering department at the University of Missouri and will be succeeded by Mack M. Jones, ranking member of the agricultural engineering staff for a number of years. Mr. Wooley is taking a six-months' leave of absence, and upon his return will engage in research work as a member of the agricultural engineering staff.

ASAE Elects J. B. Kelley a Life Member

JAMES BYRON KELLEY, professor of agricultural engineering, University of Kentucky, was recently elected by the Council of the American Society of Agricultural Engineers, to life membership in the Society. He has been a member for the past 35 years.

After earning his bachelor's degree in mechanical engineering in 1912, at Iowa State College, he was promoted from part-time to full-time instructor in the agricultural engineering department there, and to assistant professor in 1917.

In June, 1918, he enlisted in the army and was assigned as instructor in automotive service, and soon selected for field artillery officer's training. With the ending of the war in November he was honorably discharged and returned to his position at Iowa State College.

The University of Kentucky appointed him professor of agricultural engineering in August, 1919. He has headed its teaching, extension, and experimental work in the field continuously since that time.

Related work during those years has included the design and construction of farm buildings and utility in- *(Continued on page 406)*

There are all kinds of smiles! Surely the reader can sense that the one on the left in this picture is the smile of satisfaction of a job done, (it was well done, too), while on the right is the smile of anticipation of the happy experience in the job to be done. Many ASAE members will recognize these two handsome gentlemen as George A. Rietz and Arthur J. Schwantes, respectively, the outgoing and incoming presidents of ASAE at the Society's annual meeting at the Multnomah Hotel, Portland, Ore., June 21 to 23

NEWS SECTION

(Continued from page 404)

stallations for the agricultural experiment station farm at Lexington, and substation farms at Princeton and Quicksand, Ky.; the writing of many extension circulars and other publications; service as collaborator in the Bureaus of Home Economics and Agricultural Engineering, U.S. Department of Agriculture, in connection with farm housing and rural electrification surveys in Kentucky; and service as collaborator in the Soil Conservation Service and member of the advisory committee on soil erosion investigations in the Northwestern Appalachian Region.

During this time he has shown an active interest in the ASAE, has served on many of its committees, and was secretary-treasurer of its Southern Section in 1912.

His election to life membership by the Council was completed under the provisions of Article C5, Section 3, of the Constitution and Article B5, paragraph 13, of the By-Laws governing the Society.

Personals of A.S.A.E. Members

Charles E. Ball, formerly research fellow in agricultural engineering, Iowa Agricultural Experiment Station, has recently accepted appointment as agricultural engineer on the editorial staff of "Southern Agriculturist" at Nashville, Tenn.

Lee E. Bartlett is now connected with the Forest Products Division of Associated Sales & Supply Co., with headquarters at 950 Dierks Bldg., Kansas City, Mo.

Jack F. Bell has resigned his position with the agricultural extension division of the University of Delaware, to accept employment as blockman with the International Harvester Company's branch at Richmond, Va.

G. S. Bliesner has obtained a year's leave of absence from his duties at Farragut College and Technical Institute, to manage the Malheur Cooperative Electrical Association at Vale-Ontario, Ore.

Mills H. Byrom, senior agricultural engineer, Bureau of Plant Industry, Soils and Agricultural Engineering, has been transferred from Lake Worth to Belle Glade, Fla., where he is now engaged primarily in designing and testing equipment for the production of ramie fiber and by-products of the ramie plant.

Paul C. Dillon resigned recently as a blockman for the International Harvester Company in Texas, to accept employment as rental supervisor for Shary Farms, Inc., at Mission, Texas. He will serve as agricultural engineer and overseer for approximately 3,000 acres of tenant farms as well as a company-operated, 500-acre farm and 500-acre stock ranch, all under irrigation.

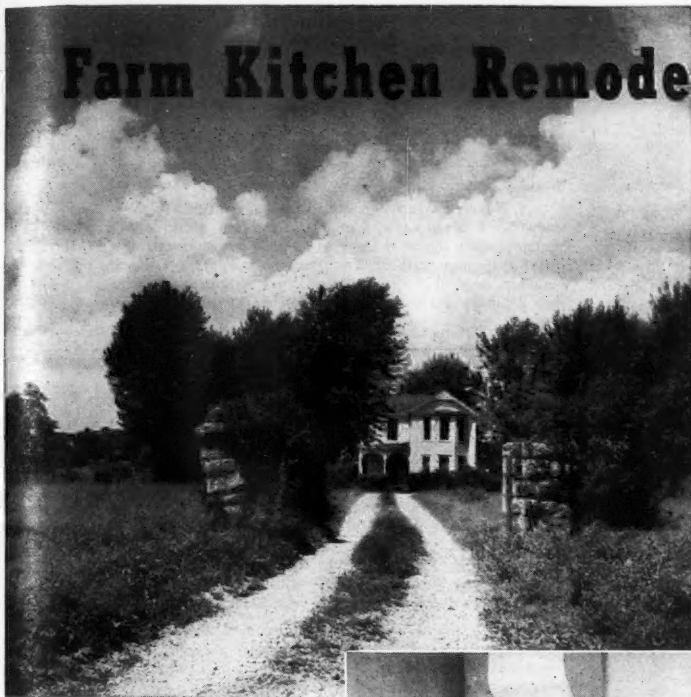
George B. Duke has resigned as professor of agricultural engineering at Abraham Baldwin Agricultural College at Tifton, Ga., to accept an assignment with the division of farm machinery of the Bureau of Plant Industry, Soils, and Agricultural Engineering, U. S. Department of Agriculture. He will be engaged in research work in sugar cane production and harvesting machinery and will be located with the USDA project at Douma, La. *(Continued on page 408)*

NEW OFFICERS OF ASAE STUDENT COUNCIL

In this picture are the four new officers, for the 1948-49 year, of the National Council of ASAE Student Branches elected by members of student branches attending the 41st annual meeting of the American Society of Agricultural Engineers at Portland, Oregon, June 21 to 23. They are: President, Thomas E. Clague, Iowa State College; 1st vice-president, Lawrence W. Larson, University of Idaho; 2nd vice-president, Robert C. Evans, Ohio State University, and secretary, Norman A. Flaten, University of Saskatchewan. From left to right, in the picture, they are: Flaten, Clague, Evans, and Larson

Farm Kitchen Remodeling with

Plywood



Farm home of Mr. and Mrs. George Hayden, Stamping Ground, Kentucky

THE VERSATILITY of Douglas fir plywood in farm home remodeling is shown in these pictures of a project conducted by the Agricultural Extension Service, University of Kentucky.

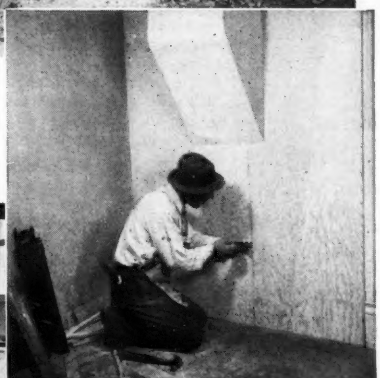
The old farm house of Mr. and Mrs. George Hayden, Stamping Ground, Kentucky, was comfortable and in good condition except for the lean-to kitchen. It was decided to remodel the dining room into a kitchen, and to refinish the old kitchen into a service porch.

One-quarter inch plywood panels were nailed over the wood paneling in the old kitchen. Panel edges were beveled slightly to form a V at the butted joints, and the panel edges were fitted smoothly around door and window openings without casings or moldings. The plywood surfaces were finished with a resin seal coat, light pastel stain and wax.

In the new kitchen area 1"x4" horizontal furring strips were nailed over the old wall on two foot centers. Similar members were cut between these to back up all vertical panel edges. One-quarter inch plywood was nailed and glued to these strips, using casein glue. Panels of similar thickness nailed to the old worn floor made a smooth base for the new linoleum floor covering. Cabinet work was built on the job using ¾" panels.

The local carpenter had no difficulties in working from the detailed plans and specifications prepared by the extension agricultural engineer. Mrs. Hayden encountered no difficulties in securing attractive paint and stain finishes on the plywood walls and ceiling.

Plywood panels one-fourth inch thick placed over worn floors make a smooth underlay for linoleum flooring.



Plywood panels were glued to furring strips nailed to the walls and ceilings. Joints between panels were filled with mixture of glue and sawdust, and sanded flush, making smooth crack-free surfaces.

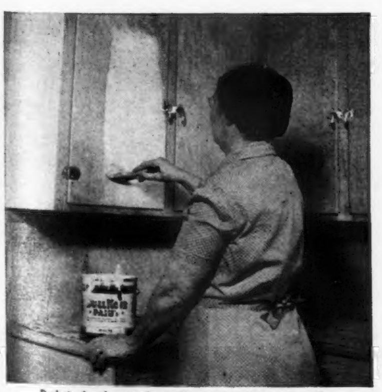
LARGE, LIGHT, STRONG

Douglas Fir

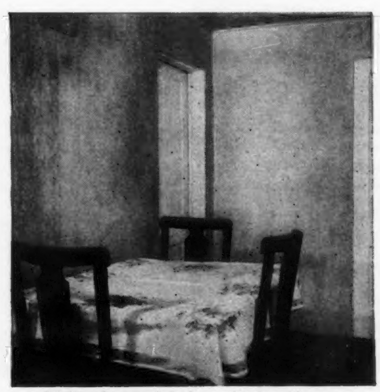
PLYWOOD

Douglas Fir Plywood Association, Tacoma, Wash.

Real Wood **Panels**



Painted plywood walls and cabinet work are achieved by starting with a thinned prime coat.



Walls of remodeled service porch are smooth and pleasant. Plywood, applied vertically, was given a light stain finish.

A built-in wood box at the outside kitchen door simplifies Mrs. Hayden's cleaning problem.

Personals of A.S.A.E. Members

(Continued from page 406)

Oscar E. Eggen, until recently director of engineering of The Oliver Corporation, was recently elected vice-president of the company in charge of all engineering.

Roland A. Glaze has resigned as chief engineer of the Weyerhaeuser Sales Co., to accept appointment as zone manager of the Toledo Scales Co. with headquarters at the company's Minneapolis office.

A. Roger Grout has resigned as district agricultural engineer of the New York State College of Agriculture to accept appointment as assistant county agent at large in agricultural engineering on the agricultural extension staff of The Pennsylvania State College. He will be engaged as a specialist in agricultural engineering, with emphasis on tile drainage in several counties of northwestern Pennsylvania.

John Heilman, formerly an agricultural economist in the Farmers Home Administration, USDA, is now farm management specialist and in charge of farm management work for the American International Association in Caracas, Venezuela. The Association is embarking upon a program of economic and social development in collaboration with the Venezuelan Government, and the work will be primarily in rural areas and will deal with such matters as agricultural production problems, marketing, housing, irrigation, development of agricultural co-operatives, supervised agricultural credit, nutrition, health, education, etc.

Russell E. Heston, formerly a member of the agricultural engineering staff at Iowa State College where he recently received his M.S. degree in agricultural engineering, is now associated with the National Association of Mutual Insurance Companies, Indianapolis, as agricultural engineer. His new work includes educational promotion and research investigations regarding farm safety and fire and wind losses.

W. G. Kaiser, in charge of farm promotion for the Portland Cement Association since 1917, and more recently manager of the Association's farm bureau, has been appointed assistant director of promotion, in which position he will give special attention to the Association's advertising, public relations, and literature production activity. Mr. Kaiser is a past-president of ASAE, a past-chairman of the Society's Farm Structures Division, and was awarded the Cyrus Hall McCormick medal by the Society in 1946 for his outstanding work in the application of engineering in the field of farm structures.

Harry Leonhardt, formerly agricultural engineer, Soil Conservation Service, USDA, is now associated with the engineering firm of Russell, Hillyer, and Leonhardt at Lamar, Colorado. He will handle those problems presented to the firm which are more closely associated with agriculture and the soil. The firm is handling the general engineering work of an agricultural area, including designs and specifications, construction, supervision, and consultation.

Thomas E. Long, formerly agricultural engineer for the Republic Steep Corp., and more recently agricultural engineer and assistant manager of the farm bureau, Portland Cement Association, was recently advanced to manager of the farm bureau, succeeding W. G. Kaiser. Following graduation in agricultural engineering from the University of Nebraska, Mr. Long served on the agricultural engineering staff of North Dakota Agricultural College from 1939 to 1944, when he joined the Republic Steel Corp.

Ausmus S. Marburger, until recently agricultural engineer and staff superintendent for the New Holland Machine Co. at New Holland, Pa., has been made general manager of Hertzler & Zook Co., a division of the Sperry Corporation, Belleville, Pa.

Chemurgists Focus Attention on Machine-Produced Crops

CROPS for which farm production and handling equipment are already available, or in advanced stages of development, were featured at the 13th Annual Chemurgic Conference, at Omaha, Nebraska, March 3 to 6.

Notable progress was reported in the processing of corn and soybeans, contributing to their over-all importance.

In the old art and science of corn processing, the progress is in both the separation and the recombining of its chemical components, to the order of its expanding starch, sugar, alcohol, oil, protein, and other markets.

Recent improvements in separation of the drying and non-drying fractions of soybean oil have given it increased utility as a raw stock from which oils can be custom-tailored to a widening variety of use requirements.

Improved and increased use of seed flax straw was indicated as adding new support to the position of flax in farm economy.

Two old-world oil crops—sesame and safflower—were indicated as subject to American redevelopment likely to further broaden the acreage and seasonal usefulness of the combine. The shattering characteristics of the former, which gave ancient meaning to the words "open sesame," is being bred out of the plant in hybrids which offer prospects of adapting this oil crop to high-effi- *(Continued on page 410)*

United Oil Bath Air Cleaner used on Minneapolis-Moline G-4 Harvestor.

air cleaner protected engines

REAP BENEFITS OF CLEAN AIR

While the Minneapolis-Moline Harvestor pictured below reaps the harvest, its engine reaps the benefits of clean air provided by a United Oil Bath Air Cleaner. The efficient dirt trapping action of this cleaner filters out harmful abrasives from air entering the engine — doubly important on agricultural equipment where harvesting and other processes kick up clouds of dust and chaff ruinous to rings, sleeves, pistons, bearings.

For over 25 years United Air Cleaners have been built for farm machinery, tractors, cars, trucks and stationary engines. The excellence of United design — its simplicity and solidity, its large oil reservoir and great dirt-trapping capacity—has long been recognized.

United's technical knowledge of air cleaner design and application is useful in solving installation problems. We invite your inquiry.

United Oil Bath Air Cleaner used on Minneapolis-Moline Universal U Tractor.

Minneapolis-Moline G-4 Harvestor and Universal U Tractor harvesting soy beans. Dust-raising harvest work makes air cleaner protection of prime importance.

UNITED SPECIALTIES COMPANY

United Air Cleaner Division, Chicago 28, Illinois
Mitchell Division, Philadelphia 36, Pa.

AIR CLEANERS ★ WHEEL GOODS ★ METAL STAMPINGS ★ DOVETAILS ★ IGNITION AND DIRECTIONAL SIGNAL SWITCHES ★ ROLLED SHAPES

NEWS SECTION

(Continued from page 408)

ciency combine harvesting. Safflower is a more recent oil crop introduction which was cited as adapted to combine harvesting and to dry climate production. In addition to yielding substantially under drought conditions, it responds with increased yields where, as, and when irrigation is possible. This has started it toward a position of importance as an alternate crop serving to broaden the opportunities for profitable agriculture in regions of low humidity. pros

Dr. Harry Miller, who was unable to be present but whose paper was presented by one of his cooperators, reported a castor bean harvester in the field trial stage of development. This is a case in which agricultural engineers and plant breeders are meeting each other half way in designing a machine-crop combination to fit an opportunity in American agriculture.

A modified hemp binder was said to be performing quite successfully in harvesting ramie. Progress in chemical decortication and other phases of processing have improved the prospects of ramie achieving an important place in the fiber industries, and as an engineering material. It is well known as a superior packing for marine propeller shafts, and has unique fiber properties for use in woven industrial belts, hose, and probably rope.

Agricultural alcohol, for power and other uses, was spotlighted briefly and inconclusively against today's stage setting of new high petroleum demand, high grain prices, alternative sources, growing power requirements in countries short of petroleum, and engineering trends in internal-combustion engine design. Considerable was said for its power use possibilities as a supplement to low-grade gasoline for boosting temporary peak load capacities.

Direct farm and agricultural engineering interest was also indicated in the clipping and drying of buckwheat for the production of rutin, one of the newer biologicals of rapidly increasing importance. Increased yields of ripe buckwheat, as a result of the clipping, were indicated. A considerable increase in buckwheat acreage to supply the demand for rutin is in prospect.

Wheeler McMillen, president of the National Farm Chemurgic Council, spoke briefly at the opening session. He called attention to an increased interest in efficient production and high productivity as a means of alleviating the shortages which lead to war. He pointed out that, while the United States now has 40 million more population than in 1920, few new acres are open to farming, and increasing imports of agricultural commodities, non-food uses of farm products and by-products are and will continue to be justified. They help to conserve exhaustible mineral resources and encourage more abundant food production by improving its economy.

Mr. McMillen introduced the Hon. Val Peterson, governor of Nebraska, who briefly summarized the interest of the state, and the whole Midwest in chemurgic progress.

Arnold P. Yerkes, in presiding over a session on corn chemurgy, paid high tribute to the work of the four regional research laboratories of the U. S. Deparment of Agriculture. He indicated that their wartime advancement of penicillin production alone had more than repaid their total cost, in lives saved.

L. F. Livingston was in top form in his presentation of the significance of research in raising the American standard of living. He challenged any country or theory of government where individual freedom and incentive are lacking, to show technical progress and material prosperity in any way comparable with that in the United States.

Dr. E. C. Lathrop was unable to be present. His paper on the industrial utilization of corn crop residues was presented by one of his co-workers.

Other A.S.A.E. members noted present at the Conference were Elmer F. Clark, Paul N. Doll, and V. S. Peterson.

Major emphasis throughout the Conference was directed toward the chemurgic philosophy of abundant production from inexhaustible resources, and the opportunity it offers for meeting current economic and humanitarian needs in the United States and throughout the world.

Applicants for Membership

The following is a list of recent applicants for membership in the American Society of Agricultural Engineers. Members of the Society are urged to send information relative to applicants for consideration of the Council prior to election.

Blackwell, Elwood T.—Agricultural engineer, Mecklenburg Electric Cooperative, Chase City, Va.

Brown, J. H.—Trainee, John Deere Plow Co. (Mail) 2921 Harlin Dr., Nashville, Tenn.

Burford, James B.—Research engineer in hydraulics, Soil Conservation Service, USDA. (Mail) 121 Husband St., Stillwater, Okla.

Butler, B. J.—Assistant in spray equipment research, agricultural engineering dept., University of Illinois, Urbana, Ill. (Mail) 100 W. California.

Carroll, Thomas—Chief engineer, combine div., Massey-Harris Co., Ltd., 915 King St. W., Toronto, Ont., Canada.

Chancy, James F.—Agricultural engineer, Soil Conservation Service, USDA. (Mail) P. O. Box 285, Ludowici, Ga.

Emmert, Leonard R.—Manager, rural electrification, Westinghouse Electric Corp., East Pittsburgh, Pa.

Friedmann, A. R. J.—Vice-president in charge of sales and engineering, Skinner Irrigation Co., Troy, Ohio.

Forehand, James F.—Cotton ginning specialist, Georgia Agricultural Extension Service, Athens, Ga. (Mail) P. O. Box 82.

George, William C.—Instructor in agricultural engineering, Arkansas State College, State College, Ark.

Gillespie, Lowry H., Jr.—Agricultural engineer, Appalachian Electric Power Co., Tazewell, Va.

Goss, W. A.—Chief engineer, implement div., Detroit Harvester Co. (Mail) Zane Hotel, Zanesville, Ohio.

Greene, Ralph B.—Head mechanic, agricultural engineering dept., North Carolina State College, Raleigh, N. C. (Mail) Box 5514, State College Station.

Jean-Michel, Marc—Agronomist, Department de Agriculture, Service des Eaux et Forests, Port-au-Prince, Haiti. (Mail) c/o 63 Rue du Champ de Mars.

Knox, J. B.—Design and experimental engineer, Fleury-Bissell, Ltd. (Mail) Fergus, Ont., Canada.

Kumar, Hans—Engineer in charge, Central Tractor Organization, Ministry of Agriculture, Government of India, New Delhi, India. (Mail) Hutment No. 3, Rouse Ave., Lane.

Larson, Curtis L.—Instructor in agricultural engineering, University of Minnesota. (Mail) 1211 36th Ave., N., Minneapolis, Minn.

Lee, T. J.—Service manager, tractor and implement div., Ford Motor Co. of Canada, Ltd., Windsor, Ont., Canada.

Loupo, Marshall W.—Instructor in agricultural engineering, University of Vermont, Burlington, Vt. (Mail) 15 N. Williams St.

Low, Charles J.—Engineer, Jackson & Church Co., 306 Stoker Dr., Saginaw, Mich.

Martin, T. E.—Chief engineer, The Oliver Corp, Springfield, Ohio.

Meyers, Vincent J.—Agricultural field representative, Portland Cement Assn. (Mail) 4354 Morgan Ave. N., Minneapolis, Minn.

Miller, Kenneth A.—R. R. No. 3, Tahlequah, Okla.

Peterson, Edward—Agricultural engineer, Skoinska Lontmannens Maskin A-B, Vellinge, Sweden. (Mail) Eskilstorp 12.

Prosser, D. S., Jr.—Engineer, Citrus Experiment Station, Lake Alfred, Fla.

Rhodes, Arthur J.—Rural service representative, Louisiana Power & Light Co. (Mail) Gibsland, La.

Sapper, Herbert D.—Assistant manager, Nicaragua Sugar Estates, Ltd., Ingenio San Antonio, Nicaragua, C. A.

Scott, James R.—Associate professor of agricultural engineering, Ontario Agricultural College, Guelph, Ont., Canada.

Shimon, Donald F.—Engineer, farm equipment div., Butler Mfg. Co. (Mail) 930 S. Washington St., Independence, Mo.

Simpson, W. Carlos—Box 55, Liverpool, Tex.

Smith, Ralph E.—Instructor, Veteran's Farm Training, Cedartown, Ga. (Mail) R. R. 3.

Steele, John C.—Assistant extension agricultural engineer, Extension Service, College of Agriculture, Lincoln 1, Nebr.

Tropeano, Philip L.—Chief engineer, Larchmont Farms Co., Lexington 73, Mass.

Turner, C. E., Jr.—Seminole Truck & Tractor Co., Seminole, Tex.

Winter, Roland W.—Instructor in agriculture, Sibley High School. (Mail) R. R. 1, Gibson City, Ill.

Yandre, Thomas E.—Vice-president and sales engineer, Farm & Home Machinery Co., Inc., 430 W. Robinson Ave., Orlando, Fla.

(Continued on page 414)

Applicants for Membership

(Continued from page 412)

TRANSFER OF GRADE

Babb, Joel M.—Agricultural engineer, applications & loans div., Rural Electrification Administration, USDA, Washington, D. C.

Dodd, William A., Jr.—Oak Ridge Production Div., U. S. Atomic Energy Commission, Oak Ridge, Tenn. (Mail) 313 Florida Ave. (Junior Member to Member)

Dodds, Murray E.—Agricultural engineer, power and machinery section, Dominion Experiment Station, Swift Current, Sask., Canada. (Associate to Member)

Mills, D. L.—Manager, Bowling Green Lumber Co., Inc., Bowling Green, Va. (Junior Member to Member)

Pfost, Harry B.—Associate professor of agricultural engineering, Alabama Polytechnic Institute, Auburn, Ala. (Junior Member to Member)

New Literature

SAE HANDBOOK (1948 edition). Cloth, lxiv + 877 pages, 5½x8 inches. Society of Automotive Engineers, (New York 18, N. Y.)

This edition gives new specifications under classifications electrical equipment, fleet operation lighting, materials, and parts and fittings. Classifications in which one or more specifications have been revised include aeronautical, electrical equipment, lighting, materials, parts and fittings, and tools.

TILE DRAINAGE (fourth edition), by James A. King (deceased) and W. S. Lynes. Paper, V + 129 pages, 6x9 inches. Illustrated. Mason City Brick and Tile Co. (Mason City, Iowa), $1.00.

Revisions for the current edition, to include the latest information on the subject, were under way at the time of Mr. King's demise, and were completed by Mr. Lynes. It has chapters on the history of tile drainage, soil make-up and its importance, why you should tile drain your land, tiling increases farm profits, tile benefits in a nutshell, when tiling is necessary, how tiling controls the water supply, how tiling regulates the heat supply, how tiling influences air supply, how tiling increases the available plant food supply, how tiling lengthens the growing season, how tiling reduces cost of production, how tiling removes alkali, drainage of peat soils, how tile work, drainage outlets, joint outlet systems, location of drains, spacing and depth of tile as related to water table, what sizes of tile to use, use of drain tile in other ways, some very important points including tricks of the trade, tiling as an aid to erosion control, what tile to use, and machines for digging the ditch.

THE ASBESTOS CEMENT PRODUCTS REFERENCE BOOK. Paper, 22 pages, 8½x11 inches. Illustrated. Asbestos Cement Products Assn. (509 Madison Ave., New York 22, N. Y.)

A users' guide to asbestos cement building materials, with answers to questions most likely to arise concerning their uses, methods of handling, and application.

FARM BUILDING INSULATION. Paper, 48 pages, 6x9 in. Illustrated. Insulation Board Institute (111 W. Washington St., Chicago 2, Ill.)

Practical instructions for controlling inside temperature and other atmospheric conditions through the correct use of insulating board.

SCIENTIFIC AND TECHNICAL SOCIETIES AND INSTITUTIONS OF THE UNITED STATES AND CANADA (Fifth Edition). Cloth, 371 pages, 7x10 inches. Indexed. National Research Council (Washington 25, D. C.), $5.00.

A directory of societies, associations, and similar organizations of record which contribute to the advancement of knowledge in the natural sciences and related fields. Information covered briefly includes organization name, address, officers, history, purpose, membership, meetings, and publications.

New Federal and State Bulletins

Buildings and Equipment for Vocational Agriculture Instruction, by F. C. Fenton and H. L. Kugler, Kansas State College Bulletin No. 4, March 1, 1948 (Engineering Experiment Station Bulletin No. 57). (Manhattan, Kas.)

Functional considerations influencing structural design, selection of equipment, and arrangement of equipment.

Manual of Demonstrations and Lessons in Teaching Farm Wiring, by D. C. Sprague and J. B. Stere. Pennsylvania School of Agriculture (State College), Miscellaneous Publication No. 1. $1.00.

Features lessons and demonstrations to teach 12 basic divisions of the subject. A discussion of method and procedure, and demonstration equipment plans and specifications are included.

Your Farmhouse Insulation and Weatherproofing, by Harry L. Garver, et al. USDA Miscellaneous Publication No. 633 (February, 1948). A two-color bulletin emphasizing important points on the subject applicable on new construction, remodeling, improvement, and routine maintenance.